Chemical & Engineering NEWS

Tire cord makers fight for share of shrinking market
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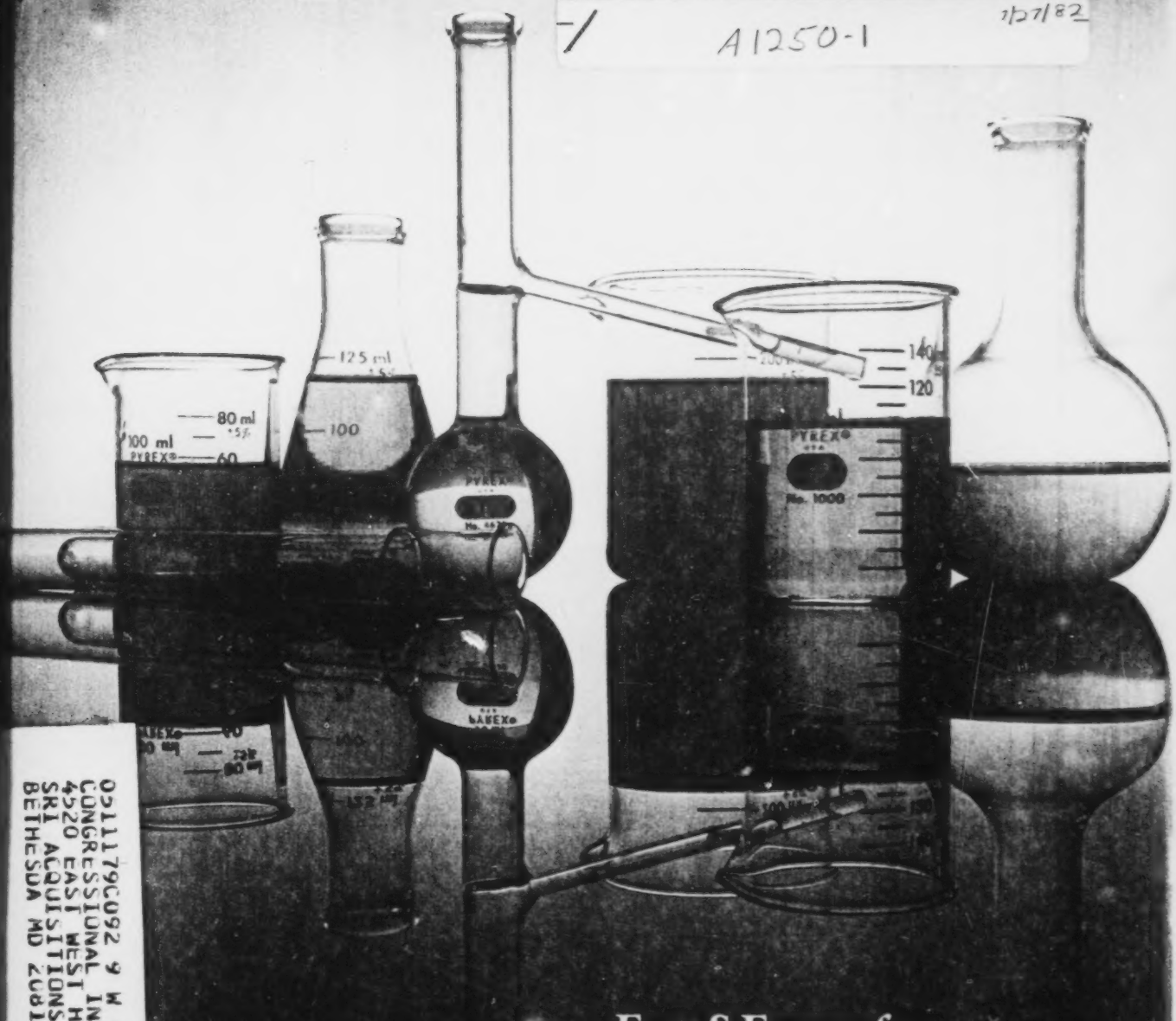

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Facts & Figures for Chemical R&D

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Chemical & Engineering NEWS

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- ***Morton Thiokol,*** *the new company that will result if the merger of Morton-Norwich and Thiokol goes through, will have a solid base in specialty chemicals.* ***Page 7***
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PROFITS PLUMMET AVERAGES 36% SO FAR

Events are bearing out earlier predictions as second-quarter results from chemical companies show another big drop from last year.

There is little good news in any of the reports thus far, as the recession seems to have spread to all segments of the chemical industry, including some previously very stable product lines such as agricultural specialties.

The only good news seems to be that in many areas the cost of raw materials has dropped far enough to allow for some profitability.

Of 20 chemical companies that have reported second-quarter earnings so far, 18 had decreases in earnings, ranging from Allied Corp.'s modest 6% drop to Akzona's going into the red. And sales declined for 17 of the companies, indicating that demand has a long way to go before the companies begin to return to reasonable profit growth.

Combined earnings for the 20 companies dropped about 36% in the quarter from the year-before period to a total of about $692 million. At the same time, combined sales for these companies declined 8% to a total of about $16.0 billion.

For the first six months of 1982, results for the 20 companies are little better. In the first half, sales fell an average of 7% from last year's first half to a combined $32.0 billion, and earnings dropped an average of 30% to a combined total of $1.46 billion.

The result is that profitability among the companies is plummeting. Average profit margin (earnings as a percentage of sales) for the 20 companies has fallen to 4.3% in the second quarter from 6.2% in the same period last year. For the first half, average profit margin was 4.6%, compared to 6.0% in first-half 1981.

It is no wonder that results are as bad as they are. Production in the chemical industry is still down considerably, giving the chemical economy quite a bit of unused production capacity. And prices are soft all through the industry as demand for product is weak back through the entire production chain.

The economic recovery that for a long time has been just around the corner, according to economists, is still that: around the corner. The problem is that every time the economy gets a step closer to that corner, the corner seems to move two steps farther away.

The automobile industry continues to slump in spite of small periods of buying, usually brought on by rebates or other sales incentives. And housing construction is still as bad as it has been, largely because of restrictive interest rates. The housing market is in such bad shape that developers not only are not selling new houses, but they have taken to auctioning off model houses in developments as a way to get rid of them and cut down carrying costs.

Fertilizers also remain in trouble as the strength of the dollar against other currencies has cut exports from

Earnings continue to drop at chemical companies

	Second-quarter 1982						First-half 1982					
	Sales ($ Millions)	Earnings[a] ($ Millions)	Change from 1981 Sales	Change from 1981 Earnings	Profit margin[b] 1982	Profit margin[b] 1981	Sales ($ Millions)	Earnings[a] ($ Millions)	Change from 1981 Sales	Change from 1981 Earnings	Profit margin[b] 1982	Profit margin[b] 1981
Air Products[c]	$ 380.7	$ 24.2	−2%	−14%	6.4%	7.2%	$ 779.7	$ 53.5	−3%	−18%	6.9%	8.1%
Akzona	254.8	−4.3	−19	def	def	1.8	545.4	−7.0	−12	def	def	1.4
Allied	1595.0	82.0	−1	−6	5.1	5.5	3209.0	145.0	−1	−15	4.5	5.4
American Cyanamid[d]	901.1	31.4	—	−35	3.5	5.0	1746.6	59.8	−2	−36	3.4	5.2
Chemed	64.8	4.0	2	−30	6.2	10.9	124.7	9.2	2	−14	7.4	8.8
Dow Chemical[e]	2728.0	77.0	−11	−59	2.8	6.2	5509.0	174.0	−8	−53	3.2	6.2
Ethyl[f]	417.6	27.9	−8	14	6.7	5.4	820.3	45.1	−7	2	5.5	5.2
H. B. Fuller	83.0	3.0	−2	−21	3.6	4.5	155.6	4.0	−4	−38	2.6	4.0
Philip A. Hunt	29.7	2.0	4	8	6.7	6.6	59.6	4.0	9	38	6.7	5.3
GAF	163.4	8.9	−6	107	5.4	2.5	302.9	5.1	−14	−31	1.7	2.1
B. F. Goodrich[g]	793.5	15.0	−4	−43	1.9	3.2	1500.0	−3.4	−6	def	def	2.2
W. R. Grace	1630.2	76.9	−4	−23	4.7	5.9	3093.4	221.1	−3	20	7.1	5.8
Hercules	651.0	22.3	−9	−46	3.4	5.8	1291.0	44.2	−6	−48	3.4	6.1
Monsanto	1623.4	86.2	−13	−8	5.3	5.1	3355.1	233.7	−11	−13	7.0	7.2
National Distillers[h]	464.9	22.3	−11	−37	4.8	6.8	929.3	39.2	−10	−44	4.2	6.7
PPG Industries	882.1	45.7	−1	−29	5.2	7.2	1600.0	69.8	−6	−42	4.4	7.0
Reichhold Chemicals	218.8	3.8	−14	−46	1.7	2.8	432.7	7.1	−12	−39	1.6	2.4
Rohm & Haas[i]	528.0	28.0	−3	−17	5.3	6.2	1003.3	44.0	−2	−28	4.4	6.0
Stauffer Chemical	305.6	17.2	−19	−25	5.6	6.1	935.9	99.3	−7	−11	10.6	11.0
Union Carbide	2299.4	118.2	−14	−35	5.1	6.8	4611.5	209.0	−13	−40	4.5	6.6

a Earnings from continuing operations, excluding extraordinary and nonrecurring items. b Earnings as a percentage of sales. c Excludes $9.3 million nonrecurring gain in second-quarter 1982. d Excludes $3.4 million charge in second-quarter 1982, $9.6 million gain in first-half 1982, and $3.4 million gain in second-quarter 1981. e Excludes nonrecurring gain of $120 million in second-quarter 1982. f Includes results from First Colony Life Insurance from May 14, 1982. g Excludes gain of $4.4 million in second-quarter 1982 and gain of $18 million in first-half 1981. h Excludes nonrecurring loss of $4.3 million in second quarter and net gain of $7.2 million in first-half 1982. i Excludes nonrecurring charge of $13.4 million in second-quarter 1981 and $9 million in first-half 1981. def = deficit.

the U.S. and purchasing power of U.S. farmers has dwindled along with farm income.

The problems on the farm in the second quarter now have spread to pesticides, which have been a rock of earnings growth over the past few years. For instance, Monsanto, which is used to seeing big increases from its Lasso and Roundup herbicides, had a 2% drop in operating profit in its agricultural products division in the second quarter.

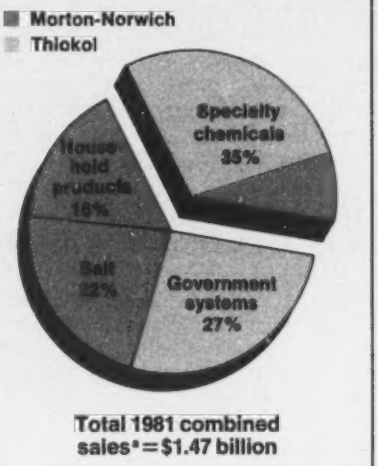
At American Cyanamid, chairman James G. Affleck says of the farm economy: "Depressed conditions in U.S. agriculture, light insect infestations, and changes in customer buying patterns all combined to reduce pesticide sales."

Lower raw material costs helped some producers in the second quarter. For instance, Union Carbide chairman Warren M. Anderson says that despite lower operating rates and depressed prices, gross profit margins in the second quarter were higher than in the same period a year ago. This was largely because of lower raw material costs and stringent cost controls, he says.

National Distillers chairman Drummond C. Bell comments that the company's high-density polyethylene operation was profitable because of lower costs for ethylene.

Just when the economy is going to turn upward is still anyone's guess, and the uncertainty seems to be troubling chemical executives. Hercules chairman Alexander F. Giacco says, "General business activity in the markets for our products showed no improvement in the second quarter. ... As to an anticipated recovery, the industrial segment of the economy, which is capital-intensive, will show progress once the federal government resolves its financial problems. The budget situation has caused shortages of capital and, consequently, extraordinarily high interest rates. The resolution of this problem is necessary to restore confidence not only in financial markets but in consumer attitudes as well." □

Chemicals would be largest part of combined company



Total 1981 combined sales* = $1.47 billion

* Excludes sales of pharmaceutical division, sold by Morton-Norwich in June to Procter & Gamble.

Merger would be big in electronics chemicals

Morton-Norwich Products, fresh from selling a pharmaceuticals division in June to Procter & Gamble, is charting itself a new course. It is committing itself heavily to specialty chemicals by its latest decision, to acquire Thiokol. If approved by stockholders, the acquisition would result in a new company, Morton Thiokol, with more than 34% of sales in specialty chemicals.

There would be one especially significant overlap from the two merged firms' chemical markets: specialty chemicals for the electronics industry. Morton-Norwich, for example, has a major interest in epoxy molding compounds as encapsulants for semiconductors, integrated circuits, and other electronic devices. And Thiokol is building a tidy business with photoresists, solder masks, and copper deposit systems for the electronics industry.

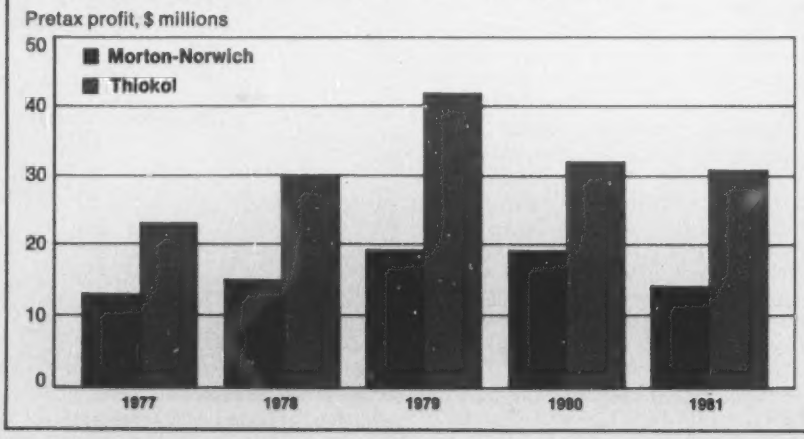
The move also would give Chicago-based Morton-Norwich a new area of sales in defense- and space-related businesses. Morton-Norwich's fiscal 1981 sales, exclusive of pharmaceuticals, totaled nearly $747 million. Of this, 44% was from salt and related products, 31% from household products, and the remainder from various specialty chemicals.

For Thiokol, presently headquartered in Newtown, Pa., 1981 sales of specialty chemicals amounted to almost $317 million, primarily for electronics applications. It also had sales of $404 million in government systems, which includes such products as solid-propellant rocket motors and propulsion systems for the military and other high-technology areas.

For the new company, a major task would be to raise profitability of chemical operations, especially in what is now Morton-Norwich. Although its specialty-chemical operations accounted for 20% of sales in the first nine months of fiscal 1982 (ended March 31), they contributed only 13% of operating profits. Similarly, household products accounted for 23% of sales, but only 17% of operating profits. Thiokol's chemicals performance was somewhat better: Specialty chemicals accounted for 44% of the company's sales in 1981 and provided 50% of operating profits.

Under the merger agreement, Morton-Norwich is offering $50 per share for up to 5.7 million shares, or approximately 49.5%, of Thiokol's common stock. Morton-Norwich also will make a tender offer for at least $70 million of its own shares. On Aug. 13, both tender offers will expire. Shareholders for the two companies will have the opportunity to vote on the merger at meetings to be called later this year, probably in September.

Both merging chemical units have profit drops



Tire-cord makers vie for dwindling market

Slow automobile sales and increasing dominance of radial tires are cutting into traditional sales and shares of fibers

Patricia L. Layman
C&EN, New York

You may not be too interested in your neighbor's plans for a summer vacation. But if it happens to involve a lot of driving—across country, for example—tire-cord makers are. That's because long-distance driving will cause tires to wear out faster, so more will be needed—thereby requiring more tire cord.

Such seemingly small developments will be increasingly important to the tire-cord industry over the next few years. Not only is there a traditional flux in markets among fiber families, the entire market is shrinking as the number of tires sold declines. Also, the poundage of tire cord used in each tire is decreasing, as improved fibers impart longer life and the size of the tire itself is trimmed.

The tire-cord industry at present is probably a little shy of 700 million lb. That's up slightly—4%—from 1981 tire-cord consumption, which, in turn, was up 3% in poundage after two successive years of decline as the tire industry had dramatic slumps in production. And the outlook for growth at least appears to be encouraging: a little more than 5% per year for the next five years.

That is deceiving, however, because most of the growth is coming in steel wire, not tire cord, and that reflects the increasing market penetration by radial tires, most of which are reinforced with steel. Some 73% of passenger-car radial tires, including both replacements and original equipment, are reinforced with steel, and 92% of all truck radials have steel reinforcement. Because steel wire is heavier than synthetic fiber cord, its use on a unit-for-unit basis mounts up faster than that of fiber. Thus, as sales of radials rise, the increasing use of steel skews what otherwise would be a growth pattern showing only very slight increases, at best.

The heavier weight of steel wire, however, may give some fiber makers a means to increase their sales. By arguing that their fibers allow construction of lighter-weight tires, saving weight overall on a car or truck and thereby contributing to greater fuel economy, makers of glass fiber and aramid fiber reinforcements, in particular, are going after the radial-tire market.

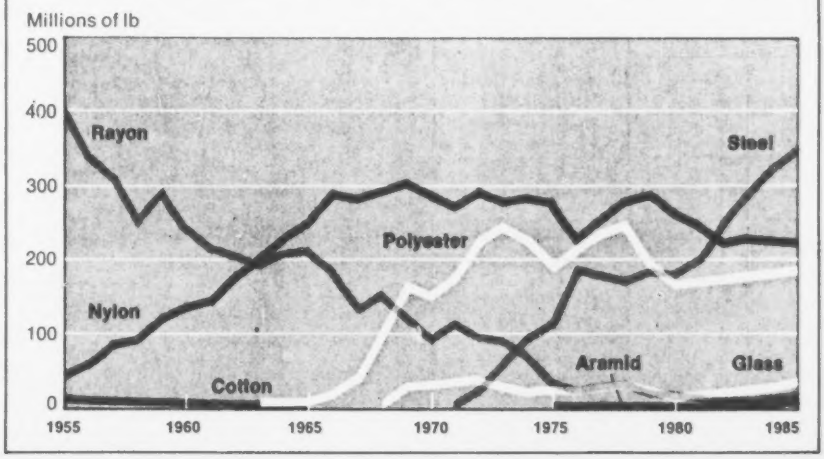
Glass fiber probably has the best chance of wresting a significant portion of the business from steel cord, because of a favorable economics picture. It is lighter than steel, and doesn't have what producers love to point out as the potential Achilles heel of steel—its poor adhesion to rubber, and a tendency to rust if a tire is nicked or slashed. And glass is lower in cost than aramid, allowing it to be considered for mass-marketed tires. But whether it reaches the optimistic position that glass-fiber makers envision remains to be seen. Fiber makers themselves acknowledge the image problem in a comparison between steel and glass. But they are relying on good performance over the years that glass fiber has been used to, to convince tire manufacturers to favor it.

Aramid makers—or more significantly, Du Pont, the only producer in the U.S. of aramid fiber—also are after the radial-tire market. But Du Pont is going after passenger-car tires and truck tires with different marketing pitches. Because the cost of aramid is steep compared with other fibers, it will be held to premium-performance passenger-car tires, the company says. High-speed performance and prestige must outweigh price.

Truck tires, on the other hand, are more promising for volume sales of aramid. Aramid fibers, Du Pont says, can replace steel on a one-to-five weight basis. That cuts weight for each tire; for large trucks, that can mean significant savings. And because the tires are lighter, they run cooler, extending the life of the tire. First target is carcass reinforcement, with Du Pont's target date the second half of 1983. The 100% aramid tire—aramid carcass and reinforcing belts—will come along more slowly, with the company figuring that 1984 would be the earliest possible date.

Although aramid fibers are competing for a market against steel carcass reinforcement in radial truck tires, glass fibers soon may be competing against polyester for carcass reinforcement in passenger-tire radials. Glass fiber makers such as Owens-Corning Fiberglas say that although the performance of their material doesn't offer any economic advantages for what is essentially the same performance as that given by polyester, within five years there will be a discernible economic advantage

Aramid fibers are latest entry in classic life-cycle of tire cord



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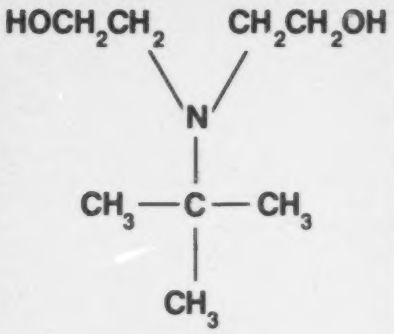

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to using glass-fiber reinforcement for radial tire carcasses.

Meanwhile, polyester producers aren't sitting still. They got into the business early on by taking a market segment—cord for bias-ply and bias-belted passenger car tires—away from nylon, and they aren't going to give up their markets without a fight. New-generation polyester fibers will help to fight off newer entrants, both Celanese and Allied think, both for the remaining, although dwindling, market for bias-ply and bias-belted passenger-car tires, and for getting into truck tires. Ironically, improved fib[illegible]y help reduce this polyester m[illegible]et. Monoply tires, for example, use a single-ply fiber for reinforcement belting, rather than a multiple bundle of fibers—doing as good a job with less polyester.

But new polyester variants also will expand markets, say the two companies, the only remaining polyester tire-cord suppliers. For example, according to one report, tire makers are evaluating some of the newest polyester fibers for use as a radial belt reinforcing material, a direct competitor with steel, glass fiber, and aramid.

And polyester, having a secure grip on reinforcement for passenger-car bias-ply and bias-belted tires, is going after similar work in truck tires. That market, however, is held now by nylon. Nylon producers, which watched while polyester took the passenger-car tire business away, think that truck tires are altogether a different business.

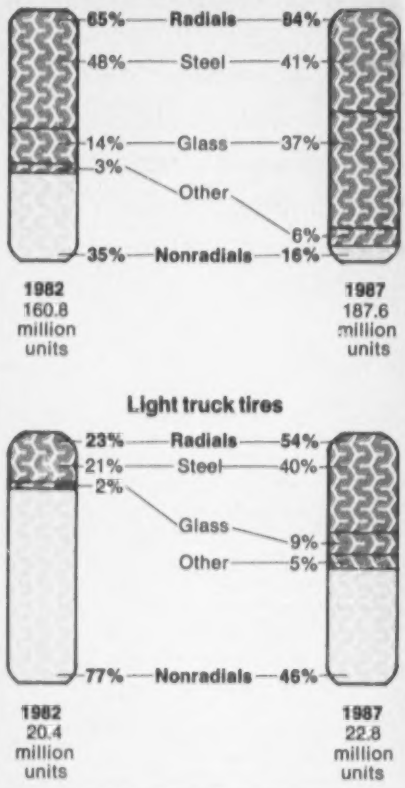
Nylon lost its hold in the passenger-car tire business, which it had wrested from rayon in the early 1960s, because of one primary drawback: the tendency to "flat-spot" in the winter. When a car was parked overnight, for example, the tire temporarily would flatten slightly along the ground, and it would take a few minutes of driving to work the thump out of the tire. Auto drivers found that annoying; Detroit got the message and turned to polyester tires for its products.

Nylon's durability and toughness, however, proved ideal for truck tires, which still are primarily bias ply or bias belted. And nylon cord producers—the only three in the U.S. now are Allied, Du Pont, and Monsanto—believe that bias-ply and bias-belted truck tires will continue to dominate for quite a while.

Radial tires, they point out, are exceptionally well suited for long-distance driving over good roads. But many trucks are designed for off-the-road operation, or are driven short distances, or are driven on poor roads. And in international markets, good highways—interstate or autobahn quality, for example—are the exception, not the rule. Under those conditions, there would be less incentive from a tire-performance viewpoint to switch from bias-ply to radial tires. If a developing country already had technology for making bias-ply tires, there probably would be even less incentive. Nylon will continue to be the fiber of choice there, producers predict, adding that, indeed, it will be a growth fiber.

Meanwhile, rayon continues to survive as a tire cord, even as critics try to write obituaries for it. It's still used widely for bias-ply tires in Europe—in particular as an alternative to radials—and also in radials with steel wire. In the U.S., it was nearly done in as a tire fiber because of environmental costs associated with its production. But rayon makers say those cos[illegible]ve been absorbed, and that the [illegible]er is competitive with polyester, especially for premium-priced replacement tires. That's

Growing dominance of radials will revamp tire cord demand



especially true, they say, since polyester prices have firmed with the shutdown of excess capacity and the pulling out from the market by Du Pont last year and by American Cyanamid in 1980.

Rayon tire cord "isn't a growth business, but it can be a good business," says one marketer. "We see the cost-performance ratio for polyester and rayon going head-on, and there's a good long-term future."

For manufacturers of all the tire cord fibers, however, the outlook for the entire industry is not one of dramatic growth. Too many factors will hold the business down. Car sales this year, for example, are having a dramatic impact on sales of original-equipment tires, which make up about 25% of passenger-car tires. General Motors, for example, reported that first-half 1982 sales were down 10% from first-half 1981. Its commercial-vehicle sales (light-duty trucks and vans) were up 22%, but that category is only about one third the size of its passenger-car group.

Those cars that are being sold are increasingly the down-sized compacts and subcompacts, which use a down-sized tire; the most popular-sized tire last year, for replacement tires, was 14 inches. With the pressure on Detroit to make cars with increasingly high gasoline mileage ratings, the pressure to save weight falls back on the tire makers, too, forcing them to look at ways to use monoply construction, for example, or substitute lighter-weight materials.

Because the American public has been through several years of high gasoline prices and often spotty availability, they haven't been driving all that much—meaning they haven't been wearing out their tires.

Fiber makers will have to become more attuned to metallurgical developments, as steel cord increases its market penetration. One tire maker says that steel-cord producers are at the same stage of adapting product to the market that polyester fiber producers were in the 1960s. So there may be an opportunity to develop synthetic fibers to work specifically with steel wire tailored for tire cord.

Nevertheless, the market still is profitable for those who are staying in. As marginal producers drop out, or phase out fiber lines, that will leave enough market for those remaining. And with some judicious diversification into other types of industrial fibers—for applications such as hose, rope, liner fabrics—producers will be able to ride out the current hard times in auto and tire sales. □

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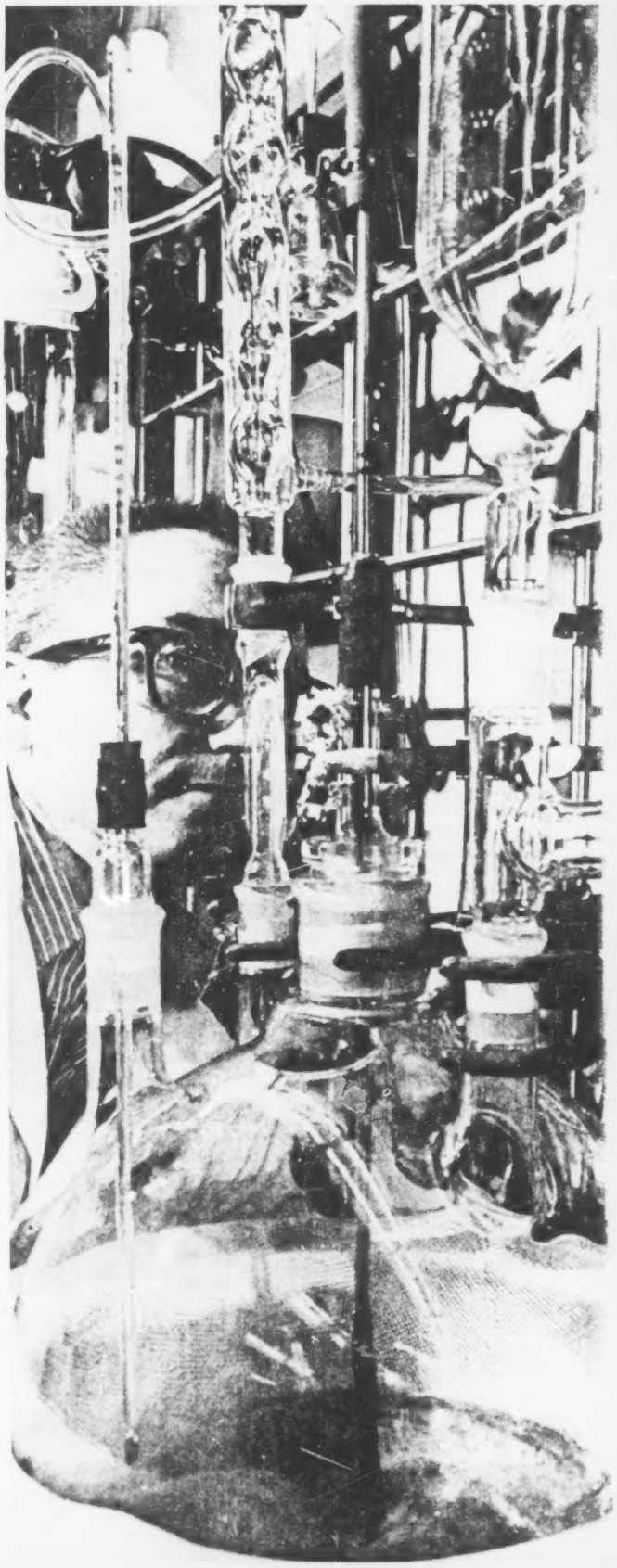
Facts & Figures for Chemical R&D



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ABSTRACTS OF PAPERS IN *CHEMICAL ABSTRACTS:* **Changes are relatively small**

% IN EACH GROUP	1981	1980	1979	1978	1977	1976	1975	1974	1973
Biochemistry	39.0%	39.8%	38.8%	38.3%	37.9%	38.8%	39.4%	36.2%	35.9%
Physical and analytical chemistry[a]	28.0	28.6	28.9	27.4	27.9	27.5	29.6	29.7	31.0
Applied chemistry and chemical engineering	19.1	18.9	19.4	20.8	19.7	18.8	15.5	18.4	16.7
Organic chemistry	8.7	7.4	7.6	8.0	8.8	8.7	9.0	9.4	10.0
Macromolecular chemistry	5.2	5.3	5.3	5.5	5.7	6.2	6.5	6.3	6.4
% OF ALL BIOCHEMISTRY ABSTRACTS									
Mammalian biochemistry	15.6%	16.3%	17.1%	17.2%	17.7%	16.3%	15.3%	16.6%	13.7%
Pharmacodynamics	12.4	12.0	11.9	12.3	12.0	12.0	12.0	11.1	11.1
Toxicology	8.7	8.3	7.4	7.5	6.2	6.4	6.6	5.6	5.9
General biochemistry	7.5	6.6	7.0	6.5	7.0	7.1	7.5	7.3	7.9
Enzymes	5.9	6.2	6.4	5.7	6.1	6.4	7.4	6.4	5.8
Others	49.9	50.6	50.2	50.8	51.0	51.8	51.2	53.0	55.6
% OF ALL PHYSICAL AND ANALYTICAL CHEMISTRY ABSTRACTS[a]									
Nuclear chemistry	21.6%	23.2%	25.1%	20.7%	21.1%	19.7%	20.0%	15.8%	19.0%
Spectra	18.0	18.2	17.0	17.0	18.1	17.8	17.2	18.2	16.8
Electric phenomena	11.0	11.2	11.4	10.9	10.5	10.5	10.3	11.4	10.8
Crystallization and crystal structure	8.9	8.1	8.2	9.2	8.9	9.7	9.6	10.1	10.2
General physical chemistry	7.2	7.1	6.6	6.6	6.8	7.0	6.8	6.4	7.2
Analytical chemistry	5.8	5.6	5.6	7.2	5.8	6.6	6.1	7.4	6.9
Others	27.5	26.6	25.8	28.4	28.8	28.7	30.0	30.7	29.1
% OF ALL APPLIED CHEMISTRY AND CHEMICAL ENGINEERING ABSTRACTS									
Metals and alloys	17.9%	22.0%	23.6%	24.0%	24.2%	27.8%	24.4%	27.9%	24.2%
Water, wastes, and pollution	24.0	22.5	20.8	20.8	23.2	18.6	15.2	18.2	15.6
Mineralogical and geological chemistry	14.1	15.7	15.8	16.8	13.4	17.6	17.5	17.6	20.2
Fossil fuels, derivatives, and related products	9.4	8.9	7.8	8.2	9.2	6.0	9.8	4.0	8.0
Unit operations and processes	6.4	6.0	6.1	6.4	5.8	4.8	5.3	5.6	7.8
Others	28.2	24.9	25.9	23.8	24.2	25.2	27.8	26.7	24.2
% OF ALL ORGANIC CHEMISTRY ABSTRACTS									
Physical organic chemistry	37.0%	38.8%	38.8%	36.8%	41.3%	38.4%	40.8%	37.3%	37.2%
Heterocyclic compounds	18.2	17.3	16.0	17.5	17.0	17.4	16.4	17.3	17.8
Organometallic and organometalloidal compounds	8.3	8.2	8.5	8.9	8.5	8.7	8.4	8.2	7.8
Aromatic compounds	8.7	7.8	8.2	8.6	8.5	8.0	8.7	9.4	10.0
Aliphatic compounds	6.6	6.0	6.0	6.9	5.9	6.5	6.3	7.1	7.1
Carbohydrates	5.4	5.7	6.0	5.2	4.6	5.1	4.9	5.5	5.6
Others	15.8	16.2	16.5	16.1	14.2	15.9	14.5	15.2	14.5
% OF ALL MACROMOLECULAR CHEMISTRY ABSTRACTS									
Plastics manufacture and uses	26.4%	28.1%	27.8%	28.1%	27.5%	26.8%	23.3%	23.1%	24.9%
Synthetic high polymers	30.3	27.0	26.3	25.6	26.5	28.3	30.6	30.6	27.7
Cellulose, lignin, paper, and other wood products	10.1	10.9	11.1	10.6	10.0	9.1	9.2	9.2	9.8
Textiles	9.9	10.1	10.1	12.1	11.0	11.1	10.2	9.8	11.0
Coatings, inks, and related products	7.5	7.4	8.1	7.5	7.5	7.6	7.3	8.1	8.1
Elastomers, including natural rubber	7.9	8.4	7.6	8.0	8.5	8.6	9.2	10.4	9.2
Others	7.9	8.1	9.0	8.1	9.0	8.5	10.2	8.8	9.3

a Includes inorganic chemistry. **Source:** Chemical Abstracts Service

U.S. PATENTS: **No significant change in total last year**

	1981	1980	1979[a]	1978	1977	1976	1975	1974	1973	1972	1971
U.S.[b]	37,356	37,152	30,605	40,979	41,383	44,162	46,603	50,643	51,501	51,515	55,988
Foreign[c]	24,463	24,675	18,248	25,123	23,886	26,074	25,291	25,632	22,638	23,293	22,328
TOTAL	**61,819**	**61,827**	**48,853**	**66,102**	**65,269**	**70,236**	**71,994**	**76,275**	**74,139**	**74,808**	**78,316**
% Foreign	**39.6%**	**39.9%**	**37.4%**	**38.0%**	**36.6%**	**37.1%**	**35.3%**	**33.6%**	**30.5%**	**31.1%**	**28.5%**

a Patent figures were low in 1979 because the Patent & Trademark Office was short of funds to print patents it might otherwise have issued. b U.S. patents granted to U.S. residents. c U.S. patents granted to residents of foreign countries. **Source:** Patent & Trademark Office

Defense spurs rise in federal R&D funding

Government obligations for R&D will climb 15% in fiscal 1982, thanks largely to a 28% increase in Defense Department funding

FEDERAL OBLIGATIONS FOR R&D: Defense and space get largest increases

Department or agency	Total R&D ($ millions)				
	1982[a]	1981[a]	1980	1979	1978
Agriculture	$ 860.0	$ 770.3	$ 687.6	$ 663.0	$ 621.3
Science & Education Administration	675.1	600.9	536.0	518.4	483.0
Commerce	288.0	336.8	342.5	309.4	283.7
National Bureau of Standards	93.5	83.0	76.2	67.8	58.3
Defense	21,523.2	16,864.1	13,981.0	12,506.2	11,553.6
Air Force	9,524.4	7,196.0	5,211.0	4,525.6	4,262.3
Army	4,020.3	3,291.0	2,980.0	2,768.7	2,548.9
Navy	6,057.6	5,061.8	4706.1	4,335.0	3,998.4
Energy	4,690.2	4,926.7	4,753.7	4,638.8	4,244.8
Environmental Protection Agency	302.6	363.1	345.0	410.1	384.6
Health & Human Services	4,168.6	3,904.8	3,780.2	3,504.9	3,207.3[b]
National Institutes of Health	3,570.8	3,328.3	3,181.8	2,953.1	2,580.9
Interior	397.8	422.9	411.3	405.8	385.2
National Aeronautics & Space Administration	6,017.4	5,407.7	5,084.1	4,411.0	3,875.4
National Science Foundation	999.9	937.4	881.8	807.9	748.8
Tennessee Valley Authority	95.5	91.1	80.1	38.4	31.5
Others	1,258.9	1,355.8	1,333.0	1,282.9	1,078.1
TOTAL	$40,602.1	$35,380.7	$31,680.3	$28,978.4	$26,414.3

a Estimated. b For Department of Health, Education & Welfare. **Note:** Fiscal years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR RESEARCH: Fell in 1981, expected to rise in 1982

Department or agency, $ millions	1982[a]		1981[a]		1980		1979		1978	
	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research
Agriculture	$ 362.9	$ 462.8	$ 319.3	$ 419.4	$ 275.6	$ 381.8	$ 256.4	$ 375.5	$ 242.7	$ 351.8
Science & Education Administration	310.8	338.5	271.2	305.7	233.0	279.8	218.6	274.8	207.9	253.2
Commerce	36.7	192.0	32.2	225.2	29.9	224.5	24.8	194.7	23.9	168.9
National Bureau of Standards	18.9	56.6	16.0	49.2	12.8	46.1	8.8	43.0	5.9	42.6
Defense	722.0	2426.2	612.9	1971.1	540.3	1721.4	363.3	1788.3	319.1	1622.1
Air Force	153.7	513.6	127.7	480.5	108.2	429.1	96.8	653.9	95.1	590.6
Army	192.4	447.1	143.1	370.7	132.2	347.1	59.5	402.7	54.5	359.8
Navy	282.0	526.4	240.4	461.1	214.9	396.2	147.7	285.1	130.3	271.7
Energy	681.7	939.1	594.7	812.7	523.1	754.2	463.0	568.9	440.5	661.7
Environmental Protection Agency	13.8	201.4	14.2	245.7	13.6	231.5	10.1	248.9	6.0	246.7
Health & Human Services	2017.0	1681.7	1871.6	1598.8	1762.7	1570.1	1576.0	1439.7	1292.3[b]	1444.6[b]
National Institutes of Health	1833.6	1270.4	1745.6	1188.6	1642.3	1145.1	1463.7	1066.4	1181.1	1051.5
Interior	79.2	273.6	77.3	287.0	71.6	282.8	72.5	266.9	145.7	164.1
National Aeronautics & Space Administration	593.0	1060.9	540.4	1014.2	559.1	1050.5	512.8	938.4	479.7	865.4
National Science Foundation	945.4	54.4	873.6	59.8	815.2	58.4	733.3	66.8	678.0	35.5
Tennessee Valley Authority	5.0	15.7	4.9	12.9	4.6	11.2	4.1	12.4	3.8	9.7
Others	99.2	690.1	95.3	674.5	92.2	622.6	81.0	575.4	67.4	447.5
TOTAL	$5555.9	$7997.8	$5036.4	$7321.3	$4692.4	$8054.1	$4097.3	$6575.9	$3699.1	$6051.8

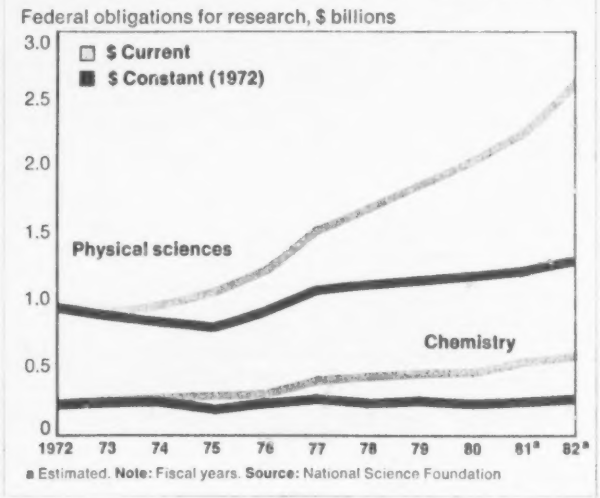
a Estimated. b For Department of Health, Education & Welfare. **Note:** Fiscal years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: Physical sciences get 20% of total

$ Millions for research only	1982[a]	1981[a]	1980	1979	1978	Annual change 1981–82	Annual change 1978–82
Engineering	**$ 3,376**	**$ 3,027**	**$ 2,830**	**$ 2,623**	**$2446**	**11%**	**8%**
Chemical	145	160	96	124	153	−9	−2
Metallurgy and materials	340	264	236	251	295	29	4
Environmental sciences	**1,377**	**1,276**	**1,261**	**1,103**	**1050**	**8**	**7**
Life sciences	**4,714**	**4,435**	**4,192**	**3,850**	**3430**	**6**	**8**
Mathematics and computer sciences	**322**	**284**	**241**	**257**	**236**	**13**	**8**
Physical sciences	**2,644**	**2,234**	**2,001**	**1,822**	**1683**	**18**	**2**
Chemistry	570	513	454	453	416	11	8
Physics	1,658	1,373	1,182	1,044	965	21	14
Other sciences	**1,100**	**1,102**	**1,073**	**1,018**	**906**	**0**	**5**
TOTAL	**$13,533**	**$12,358**	**$11,598**	**$10,673**	**$9751**	**9%**	**8%**

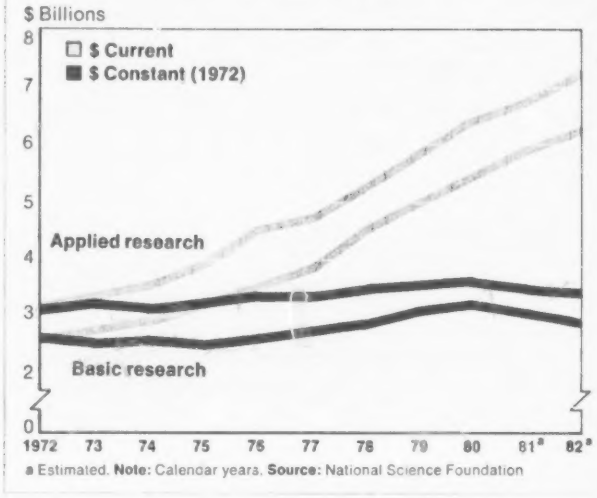
a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

Chemistry's share of federal funding for physical science has declined slightly



a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

Federal support of research tending downwards in constant dollars



a Estimated. **Note:** Calendar years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR DEVELOPMENT: Defense, space account for growth this year

Department or agency	Development ($ millions) 1982[a]	1981[a]	1980	1979	1978
Agriculture	**$ 34.3**	**$ 31.6**	**$ 30.1**	**$ 31.1**	**$ 26.8**
Science & Education Administration	25.8	24.0	23.3	24.9	21.8
Commerce	**59.3**	**79.4**	**88.1**	**89.9**	**90.9**
National Bureau of Standards	18.0	17.8	17.3	16.0	9.8
Defense	**18,375.0**	**14,280.1**	**11,719.2**	**10,354.6**	**9,812.4**
Air Force	8,875.1	6,587.7	4,673.7	3,774.9	3,576.6
Army	3,380.7	2,777.1	2,500.7	2,306.5	2,134.6
Navy	5,249.2	4,360.3	4,095.0	3,902.2	3,596.4
Energy	**3,069.4**	**3,519.3**	**3,476.4**	**3,506.9**	**3,142.6**
Health & Human Services	**469.9**	**434.3**	**447.4**	**489.2**	**466.5**
National Institutes of Health	416.8	394.0	394.4	423.0	348.3
Interior	**44.9**	**58.6**	**56.8**	**66.3**	**75.5**
Environmental Protection Agency	**87.4**	**103.2**	**99.9**	**151.1**	**132.0**
National Aeronautics & Space Administration	**4,363.4**	**3,853.1**	**3,474.4**	**2,959.8**	**2,530.2**
National Science Foundation		**4.0**	**8.1**	**7.9**	**5.3**
Tennessee Valley Authority	**74.8**	**73.3**	**64.3**	**21.9**	**18.0**
Others	**489.6**	**564.1**	**638.2**	**626.5**	**563.2**
TOTAL	**$27,068.1**	**$22,436.9**	**$20,103.2**	**$18,305.2**	**$16,663.4**

a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

BASIC RESEARCH

Defense Department support of basic chemistry rising rapidly

Department or agency	Federal obligations ($ millions)									
	1982[a]		1981[a]		1980		1979		1978	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 33.7	$ 31.5	$ 30.4	$ 28.4	$ 25.8	$ 24.0	$ 23.8	$ 22.3	$ 25.4	$ 23.6
Science & Education Administration	31.4	29.7	28.3	26.8	23.8	22.5	22.3	21.0	23.2	21.9
Commerce	15.9	2.9	13.9	2.5	12.4	2.3	8.9	1.7	6.6	1.0
National Bureau of Standards	14.5	2.7	12.8	2.5	11.0	2.2	7.9	1.6	5.7	0.9
Defense	208.0	50.9	193.0	42.8	167.1	35.7	69.9	24.5	73.1	20.9
Air Force	32.8	13.3	29.5	11.8	24.8	10.4	24.0	10.0	22.5	9.0
Army	64.5	19.0	48.6	14.8	46.0	12.7	9.7	4.3	9.3	3.7
Navy	90.0	18.4	81.0	16.0	71.9	12.3	43.6	10.1	37.9	8.2
Energy	560.9	79.8	490.4	70.9	432.1	62.1	345.6	57.7	325.4	47.9
Environmental Protection Agency	5.7	5.7	4.5	4.5	2.2	2.2	1.8	1.8	1.7	1.3
Health & Human Services	61.4	54.3	56.9	50.3	53.7	47.4	40.7	36.7	32.9[b]	29.8[b]
National Institutes of Health	60.6	53.5	56.2	49.6	52.9	46.6	40.3	36.3	32.7	29.6
Interior	8.6	6.3	8.3	5.9	7.5	5.3	9.1	6.5	12.9	10.2
Geological Survey	3.1	2.1	3.3	2.2	2.6	1.7	2.6	1.7	6.9	7.7
National Aeronautics & Space Administration	321.0	4.8	283.3	6.5	309.0	5.2	292.5	5.3	243.1	8.9
National Science Foundation	254.2	87.4	219.5	74.0	198.6	68.4	197.1	60.3	189.8	56.7
Tennessee Valley Authority	3.3	3.3	3.2	3.2	3.1	3.1	2.7	2.7	2.4	2.4
Others	8.5	0	10.7	1.2	10.0	1.2	9.4	1.3	9.1	1.5
TOTAL	$1481.2	$326.9	$1314.1	$290.2	$1221.5	$256.9	$1021.5	$220.8	$922.4	$204.2

a Estimated. b For Department of Health, Education & Welfare. **Note:** Fiscal years. **Source:** National Science Foundation

APPLIED RESEARCH

Chemistry's share of total for physical sciences is declining

Department or agency	Federal obligations ($ millions)									
	1982[a]		1981[a]		1980		1979		1978	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 32.6	$ 30.2	$ 29.5	$ 27.3	$ 26.9	$ 24.9	$ 26.9	$ 25.0	$ 26.7	$ 24.3
Science & Education Administration	29.7	28.2	26.8	25.5	24.4	23.2	24.5	23.2	23.8	22.5
Commerce	29.7	8.2	28.3	7.3	26.3	7.2	26.6	7.2	25.9	7.2
National Bureau of Standards	24.7	7.0	23.7	6.3	21.3	6.0	21.9	6.1	21.8	6.2
Defense	463.8	56.8	313.6	46.5	243.4	42.5	295.5	73.1	285.3	50.4
Air Force	51.7	13.4	47.1	13.1	41.5	12.5	96.0	19.6	71.9	13.8
Army	69.2	29.3	54.5	29.0	54.3	24.2	80.6	46.8	74.9	26.3
Navy	133.6	13.6	101.6	9.0	59.0	5.3	62.6	6.2	62.7	9.6
Energy	507.6	47.5	412.1	29.1	360.0	22.2	317.7	14.6	290.5	28.2
Environmental Protection Agency	64.5	64.5	78.5	78.5	69.4	68.4	71.4	70.7	69.1	66.4
Health & Human Services	28.9	24.9	26.8	23.1	26.0	22.5	29.1	26.1	25.4[b]	22.6[b]
National Institutes of Health	28.1	24.1	26.3	22.6	25.4	21.8	28.8	25.9	24.3	21.6
Interior	7.2	5.4	6.7	4.8	6.4	4.4	6.6	5.3	6.0	5.0
Geological Survey	5.0	4.0	4.8	3.8	3.7	2.9	4.0	3.2	4.3	3.4
National Aeronautics & Space Administration	16.5	1.2	12.5	1.1	12.2	1.5	12.3	1.1	21.7	0.3
National Science Foundation	6.8	3.1	6.3	2.9	4.6	2.3	8.7	5.3	5.9	3.6
Others	5.0	1.4	5.1	1.9	3.7	1.5	2.5	1.2	1.5	0.4
TOTAL	$1162.6	$243.2	$919.4	$222.5	$778.9	$197.4	$797.3	$229.6	$758.0	$208.4

a Estimated. b For Department of Health, Education & Welfare. **Note:** Fiscal years. **Source:** National Science Foundation

Most programs get an increase

$ Millions	1983 Probable Congressional authorization[a]	1983 Administration request	1982[b]	1981	1980	% change 1982-83[c]
Nuclear fission	$1088.0	$ 830.2	$1087.4	$ 950.5	$ 951.8	0%
Fossil energy	479.0	106.9	416.9	993.8	732.1	15
General science and research	567.5	600.9	542.7	509.4	339.9	4
Magnetic fusion	473.5	444.1	453.8	394.1	248.0	4
Basic energy research	333.7	293.8	260.2	281.3	214.4	28
Solar energy	303.0	72.2	256.9	551.4	451.9	18
Environmental R&D	230.8	139.0	219.2	226.8	201.5	5
Conservation	182.0	17.5	81.2	290.2	397.3	124
Electric energy systems and storage	67.0	37.0	49.5	111.7	94.0	35
Geothermal	55.4	0	58.5	156.0	116.2	−5
TOTAL	**$3779.7**	**$2541.6**	**$3367.9**	**$4465.2**	**$3441.1**	**12%**

a C&EN estimate based on House and Senate action to date. b Estimate. c Based on probable Congressional authorization. **Note:** Fiscal years.

Funded essentially at level of Administration request

$ Millions	1983 Probable Congressional authorization[a]	1983 Administration request	1982[b]	1981	1980	% change 1982-83[c]
Mathematical and physical sciences	$ 298.7	$ 298.7	$272.9	$ 256.5	$227.0	9%
Astronomical, atmospheric, earth, and ocean sciences	259.7	259.7	240.0	236.3	218.0	8
Biological, behavioral, and social sciences	191.7	186.7	176.0	185.6	195.7	9
Engineering	99.7	99.7	92.0	86.3	76.6	8
Antarctic program	86.4	86.4	66.0	67.4	55.8	31
Program development and management	63.1	63.1	63.5	59.2	58.2	−1
Scientific, technological, and international affairs	50.1	44.0	40.3	53.7	36.6	24
Science and engineering education	25.0	15.0	20.9	70.6	77.2	20
Ocean drilling programs	14.0	14.0	20.0	22.0	19.4	−30
Special foreign currency	2.2	2.2	4.6	4.0	4.7	−52
TOTAL	**$1090.6**	**$1069.5**	**$996.2**	**$1041.6**	**$959.2**	**9%**

a C&EN estimate based on Congressional action to date. b Estimate. c Based on probable Congressional authorization. **Note:** Fiscal years.

A little less than requested, but still up 15%

$ Millions	1983 Probable Congressional authorization[a]	1983 Administration request	1982[b]	1981	1980	% change 1982-83[c]
Air Force	$10,577.3	$11,220.4	$ 8,819.3	$ 7,133.3	$ 5,055.8	20%
Army	4,053.5	4,484.0	3,609.5	3,127.8	2,846.4	12
Navy	6,164.5	6,235.3	5,810.2	4,997.0	4,572.1	6
Defense agencies	2,202.4	2,320.7	1,697.6	1,308.9	1,044.1	30
Director, test, and evaluation	58.5	60.0	53.0	42.1	42.5	10
TOTAL	**$23,056.2**	**$24,320.4**	**$19,989.6**	**$16,609.1**	**$13,560.9**	**15%**

a C&EN estimate based on Congressional action to date. b Estimate. c Based on probable Congressional authorization. **Note:** Fiscal years.

Emphasis in 1983 is on shuttle operations

$ Millions	1983 Probable Congressional authorization[a]	1983 Administration request	1982[b]	1981	1980	% change 1982-83[c]
Conduct of R&D	**$5350.8**	**$5125.0**	**$4772.2**	**$4332.4**	**$4048.9**	12%
Space shuttle	1757.2	1718.0	2163.0	1995.0	1871.0	−19
Space flight operations	1573.5	1707.0	895.9	679.2	446.6	76
Tracking & data acquisition	503.9	508.9	402.1	339.9	332.1	25
Physics & astronomy	477.6	471.7	323.5	323.7	336.8	48
Space applications	333.3	316.3	328.2	331.5	331.6	2
Aeronautical research & technology	281.5	232.0	264.8	271.4	308.3	6
Planetary exploration	185.8	154.6	205.0	175.6	219.9	−9
Space research technology	130.5	123.0	111.0	110.7	115.6	17
Life sciences	55.7	55.7	39.5	42.2	43.8	41
Expendable launch vehicles	42.8	42.8	31.2	54.4	31.2	37
Technology utilization	9.0	4.0	8.0	8.8	12.0	12
Research & program management	**1174.0**	**1178.9**	**1144.7**	**1071.1**	**996.0**	2
Construction of facilities	**105.0**	**100.0**	**98.7**	**116.9**	**159.1**	6
TOTAL	**$6629.8**	**$6403.9**	**$6015.6**	**$5520.4**	**$5204.0**	10%

a C&EN estimate based on House and Senate action to date. b Estimate. c Based on probable Congressional authorization. **Note:** Fiscal years.

Continues its downward trend

$ Millions	1983 Probable Congressional authorization[a]	1983 Administration request	1982[b]	1981	1980	% change 1982-83[c]
Air quality	$ 55.7	$ 47.2	$ 55.7	$ 59.0	$ 68.0	0%
Energy	51.5	34.5	52.5	84.1	103.0	−2
Water quality	39.7	27.7	45.1	49.9	67.0	−12
Hazardous waste	33.9	29.6	29.5	28.3	13.0	15
Toxic substances	28.1	26.6	31.2	30.0	31.0	−10
Drinking water	25.9	22.9	28.3	21.8	23.0	−8
Interdisciplinary	10.8	4.2	5.7	6.1	8.0	89
Pesticides	6.5	6.5	5.6	7.9	13.0	16
Radiation	2.0	1.6	2.5	2.4	3.0	−20
TOTAL	**$254.1**	**$196.0**	**$256.1**	**$289.5**	**$329.0**	−1%

a C&EN estimate based on House and Senate action to date. b Estimate. c Based on probable Congressional authorization. **Note:** Fiscal years.

Administration is asking for a modest 2% increase

$ Millions	1983[a]	1982[b]	1981	1980	1979	% change 1982-83[c]
National Institutes	**$3449.5**	**$3370.0**	**$3305.6**	**$3182.5**	**$2934.8**	2%
Cancer	955.4	986.6	989.3	999.8	937.1	−3
Heart, lung & blood	577.1	559.6	549.7	527.5	510.1	3
Arthritis, diabetes, digestive & kidney diseases	369.4	368.2	369.5	341.2	302.7	0
General medical sciences	345.6	339.9	333.7	312.5	277.3	2
Neurological, communicative disorders & stroke	274.5	265.9	252.5	242.0	212.1	3
Allergy & infectious diseases	246.0	235.9	232.1	215.4	191.9	4
Child health & human development	233.6	226.3	220.6	208.9	197.3	3
Environmental health sciences	157.4	106.3	93.5	83.9	80.6	3
Eye	131.5	127.4	118.0	113.0	104.8	1
Aging	84.6	81.9	75.6	70.0	56.5	48
Dental research	74.4	72.0	71.1	68.3	64.4	3
Research Resources	**191.0**	**184.2**	**175.6**	**169.2**	**158.7**	4
National Library of Medicine	**46.0**	**44.4**	**44.7**	**44.0**	**41.5**	4
Office of the Director	**24.3**	**22.5**	**22.5**	**21.0**	**30.6**	8
Research facilities	**17.5**	**21.5**	**17.0**	**50.0**	**30.3**	−19
John E. Fogarty Center	**10.1**	**9.2**	**9.1**	**9.0**	**9.4**	10
TOTAL	**$3738.4**	**$3651.8**	**$3574.5**	**$3475.7**	**$3205.3**	2%

a Administration request. b Estimate. c Based on Administration request. **Note:** Fiscal years.

OBLIGATIONS FOR PHYSICAL SCIENCE RESEARCH: Energy provides most for chemistry

Department or agency	Federal obligations ($ millions)									
	1982[a]		1981[a]		1980		1979		1978	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 66.3	$ 61.7	$ 59.9	$ 55.7	$ 52.6	$ 48.9	$ 50.6	$ 47.2	$ 52.1	$ 47.8
Science & Education Administration	61.0	57.9	55.1	52.3	48.2	45.8	46.8	44.2	47.1	44.4
Commerce	45.6	11.1	42.3	10.0	38.7	9.5	35.5	8.9	32.5	8.2
National Bureau of Standards	39.2	9.7	36.5	8.8	32.3	8.7	29.8	7.7	27.5	7.1
Defense	671.8	107.7	506.6	89.3	410.5	78.2	385.4	97.6	358.4	71.3
Air Force	84.5	26.8	76.5	25.0	66.3	22.9	120.1	29.6	94.4	22.7
Army	133.7	48.3	103.1	38.8	100.3	36.9	90.2	51.0	84.2	30.1
Navy	223.5	32.0	182.6	25.0	131.0	17.6	106.2	16.2	100.6	17.8
Energy	1068.5	127.4	902.6	100.0	792.1	84.3	663.4	72.3	615.8	76.1
Environmental Protection Agency	70.1	70.1	82.9	82.9	71.5	70.7	73.2	72.5	70.7	67.8
Health & Human Services	90.3	79.2	83.8	73.4	79.8	69.9	69.8	62.8	58.3[b]	52.5[b]
National Institutes of Health	88.7	77.6	82.5	72.2	78.3	68.4	69.2	62.1	57.1	51.2
Interior	15.8	11.7	15.0	10.8	13.9	9.8	15.7	11.8	18.9	15.2
Geological Survey	8.1	6.1	8.0	6.0	6.2	4.6	6.6	4.9	13.2	11.1
National Aeronautics & Space Administration	337.4	6.0	295.8	7.6	321.3	6.7	304.8	6.4	264.8	9.3
National Science Foundation	261.0	90.5	225.8	76.9	203.2	70.7	205.8	65.6	195.7	60.3
Tennessee Valley Authority	3.3	3.3	3.2	3.2	3.1	3.1	5.4	5.4	5.4	5.4
Others	14.4	1.4	15.8	3.1	14.3	2.7	11.9	2.6	10.8	1.7
TOTAL	$2644.5	$570.1	$2233.7	$512.9	$2001.0	$454.5	$1821.5	$453.1	$1683.4	$415.6

a Estimated. b For Department of Health, Education & Welfare. **Note:** Fiscal years. **Source:** National Science Foundation

UNIVERSITY RESEARCH: Physical sciences get 15% of federal funds

Federal obligations, $ millions	1982[a]	1981[a]	1980	1979	1978	1977	1976	Annual change 1981–82	Annual change 1976–82
Engineering	$ 403.6	$ 351.1	$ 323.7	$ 276.9	$ 247.0	$ 249.3	$ 191.9	15%	13%
Chemical	26.3	24.3	20.2	22.7	27.0	17.5	16.3	8	8
Metallurgy and materials	85.1	70.2	57.3	51.1	48.6	48.0	46.0	21	11
Environmental sciences	336.0	314.3	297.0	275.0	225.7	205.7	170.7	7	12
Life sciences	2278.9	2114.9	1984.7	1797.6	1606.1	1405.2	1233.6	8	11
Mathematics and computer sciences	142.8	117.1	[illegible]	86.7	78.9	69.8	67.0	22	13
Physical sciences	581.1	512.4	461.0	402.6	366.2	323.[illegible]	281.3	13	13
Chemistry	202.3	176.4	159.5	139.3	122.8	14[illegible]1	99.1	15	13
Physics	313.3	273.4	246.1	215.5	198.9	163.5	147.2	15	13
Other sciences	278.9	301.4	302.7	285.2	252.3	228.4	227.5	−7	4
TOTAL	$4021.3	$3711.2	$3483.9	$3124.0	$2776.2	$2482.2	$2172.0	8%	11%

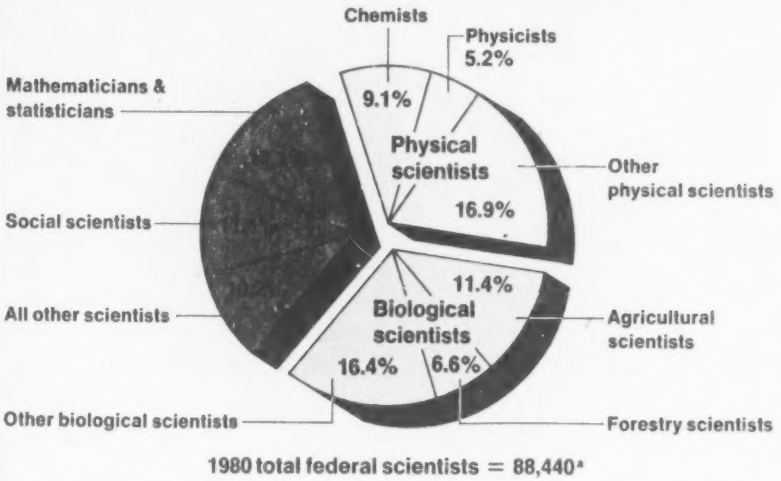
a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

UNIVERSITY BASIC RESEARCH: Federal funding for chemistry will be up 15% this year

Federal obligations, $ millions	1982[a]	1981[a]	1980	1979	1978	1977	1976	Annual change 1981–82	Annual change 1976–82
Engineering	$ 289.1	$ 237.9	$ 208.4	$ 157.1	$ 147.1	$ 134.1	$ 109.8	21%	17%
Chemical	18.7	15.5	15.1	12.5	9.4	9.5	10.2	21	11
Metallurgy and materials	76.8	63.2	51.9	45.9	42.9	41.2	34.9	21	14
Environmental sciences	296.1	273.8	255.3	228.8	190.2	165.6	127.6	8	15
Life sciences	1428.9	1318.0	1219.5	1138.9	925.9	571.1	508.0	8	19
Mathematics and computer sciences	116.3	96.7	79.8	66.9	63.7	55.7	46.1	20	17
Physical sciences	482.9	420.5	375.9	320.0	296.9	273.8	243.1	15	12
Chemistry	175.6	152.2	136.1	112.8	100.9	101.7	88.1	15	12
Physics	252.2	217.1	194.3	164.6	155.8	135.7	125.2	16	12
Other sciences	152.3	151.2	126.4	124.5	102.3	91.6	78.3	1	12
TOTAL	$2765.6	$2498.1	$2265.3	$2036.2	$1726.1	$1291.9	$1112.9	11%	16%

a Estimated. **Note:** Fisca. years. **Source:** National Science Foundation

Chemists constitute about 9% of all federal scientists



a As of October 1980. **Source:** National Science Foundation

SCIENTISTS AND ENGINEERS BY AGENCY: Biggest field for government chemists is health

Department or agency	Physical scientists	Chemists	Physicists	Engineers	Chemical engineers	Other scientists	Total scientists and engineers
Agriculture	1,443	942	31	2,711	59	20,573	24,727
Commerce	3,902	351	602	903	23	3,403	8,208
Defense	8,653	1948	3311	54,450	704	12,568	75,671
Air Force	1,083	291	500	9,501	40	1,436	12,020
Army	3,124	873	890	19,728	382	4,495	27,347
Navy	3,858	699	1898	23,955	276	2,768	30,581
Others	588	85	23	1,266	6	3,869	5,723
Energy	920	273	126	2,813	205	689	4,422
Environmental Protection Agency	1,721	636	25	1,777	139	993	4,491
Health & Human Services	2,203	2041	93	494	25	5,282	7,979
Interior	4,989	472	64	3,113	85	6,960	15,062
National Aeronautics & Space Administration	1,362	86	282	9,032	38	822	11,216
Tennessee Valley Authority	259	121	0	3,880	180	401	4,540
Transportation	151	35	10	4,811	16	705	5,667
Veterans Administration	703	630	49	936	0	2,278	3,917
Others	1,314	548	41	4,564	40	6,146	12,124
TOTAL	27,620	8083	4634	89,584	1514	60,820	178,024

Note: Data as of October 1980. **Source:** National Science Foundation

FEDERAL SCIENTISTS AND ENGINEERS: Total has increased 11% in a decade

Thousands	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
Physical scientists	27.6	27.6	27.5	27.1	27.1	26.7	26.3	26.4	27.4	30.4	29.8
Chemists	8.1	8.1	8.3	8.0	8.1	8.0	7.8	8.0	8.4	8.3	8.1
Physicists	4.6	4.9	5.0	5.1	5.3	5.4	5.5	5.6	5.8	5.4	5.4
Engineers	89.6	88.8	89.2	87.8	87.0	86.6	82.5	84.3	87.0	84.2	83.0
Chemical	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.6	1.5	1.4
Other scientists	60.8	58.3	57.2	54.3	51.6	50.6	48.8	48.4	50.1	48.7	47.4
TOTAL	178.0	174.7	173.9	169.2	165.7	163.9	157.6	159.1	164.5	163.3	160.2

Note: As of October of each year. **Source:** National Science Foundation

Healthy growth continues in industrial R&D

Spending on R&D last year by chemical producers was up about 18%, the best growth for any year in the past decade and well ahead of rising costs

TOTAL FUNDS FOR INDUSTRIAL R&D: Chemical firms hike outlays at better-than-average rate

$ Millions	1981[a]	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	Annual change 1980–81	Annual change 1971–81
Chemicals and allied products	$ 5,420	$ 4,608	$ 4,033	$ 3,584	$ 3,256	$ 3,017	$ 2,727	$ 2,450	$ 2,116	$ 1,932	$ 1,832	18%	11%
Industrial chemicals	2,700	2,273	2,023	1,835	1,685	1,524	1,391	1,299	1,119	1,031	1,009	19	10
Drugs	1,950	1,665	1,445	1,270	1,154	1,091	981	807	698	607	549	17	14
Other chemicals	770	670	565	479	417	401	354	344	299	294	274	15	11
Other industries	44,180	39,271	34,114	29,781	26,672	23,980	21,460	20,437	19,133	17,620	16,488	13	10
TOTAL	$49,600	$43,879	$38,147	$33,365	$29,928	$26,997	$24,187	$22,887	$21,249	$19,552	$18,320	13%	10%

a C&EN estimates. Source: National Science Foundation

FEDERAL FUNDS FOR INDUSTRIAL R&D: Chemical industry receives only 3%

$ Millions	1981[a]	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	Annual change 1980–81	Annual change 1971–81
Chemicals and allied products	$ 450	$ 407	$ 378	$ 366	$ 300	$ 266	$ 236	$ 214	$ 203	$ 189	$ 184	11%	9%
Industrial chemicals	425	386	360	347	284	249	218	194	183	171	159	10	10
Drugs and other chemicals	25	21	18	19	16	17	18	20	20	18	25	19	0
Other industries	15,300	13,532	12,114	10,843	10,221	9295	8369	8006	7942	7828	7482	13	7
TOTAL	$15,750	$13,939	$12,492	$11,209	$10,521	$9561	$8605	$8220	$8145	$8017	$7666	13%	7%

a C&EN estimates. Source: National Science Foundation

COMPANY FUNDS FOR INDUSTRIAL R&D: Industry boosts its R&D spending

$ Millions	1981[a]	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	Annual change 1980–81	Annual change 1971–81
Chemicals and allied products	$ 4,970	$ 4,201	$ 3,655	$ 3,218	$ 2,956	$ 2,751	$ 2,490	$ 2,236	$ 1,913	$ 1,741	$ 1,648	18%	12%
Industrial chemicals	2,275	1,887	1,633	1,488	1,402	1,275	1,173	1,105	936	860	850	20	10
Drugs and other chemicals	2,695	2,314	2,022	1,730	1,554	1,476	1,317	1,131	977	881	798	16	14
Other industries	28,800	25,739	22,000	18,938	16,451	14,685	13,092	12,431	11,191	9,794	9,006	12	12
TOTAL	$33,850	$29,940	$25,655	$22,156	$19,407	$17,436	$15,582	$14,667	$13,104	$11,535	$10,654	13%	12%

a C&EN estimates. Source: National Science Foundation

COMPANY R&D SPENDING: Budgets up sharply in 1982 for fourth year

$ Millions	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Air Products	$ 35	$ 32	$ 30	$ 24	$ 23	$ 24	$ 19	$ 16	$ 11	$ 8	$ 7
Akzona	36	32	28	25	23	20	18	17	16	13	11
Allied	198	152	105	70	56	51	40	35	31	29	29
American Cyanamid	180	164	142	124	108	96	83	73	64	52	44
Celanese	118	104	94	92	83	77	70	64	58	49	52
Diamond Shamrock	64	53	45	37	32	26	24	20	14	12	12
Dow Chemical	500	404	314	269	232	203	188	167	149	118	105
Du Pont[b]	670	575	485	415	377	367	353	336	344	286	265
W. R. Grace	65	55	45	42	37	32	28	30	32	28	22
Hercules	66	61	53	47	40	37	35	30	30	25	24
Monsanto[c]	260	221	204	161	136	132	114	116	87	82	92
Pennwalt	34	27	24	22	23	21	19	16	14	13	18
Rohm & Haas	90	77	67	54	49	45	43	45	39	32	25
Stauffer Chemical	60	51	44	37	34	33	29	24	20	17	14
Union Carbide	222	201	166	161	156	156	143	120	94	77	70
TOTAL	$2598	$2209	$1846	$1580	$1409	$1320	$1206	$1109	$1003	$841	$790
ANNUAL CHANGE	18%	20%	17%	12%	7%	9%	9%	11%	19%	6%	2%

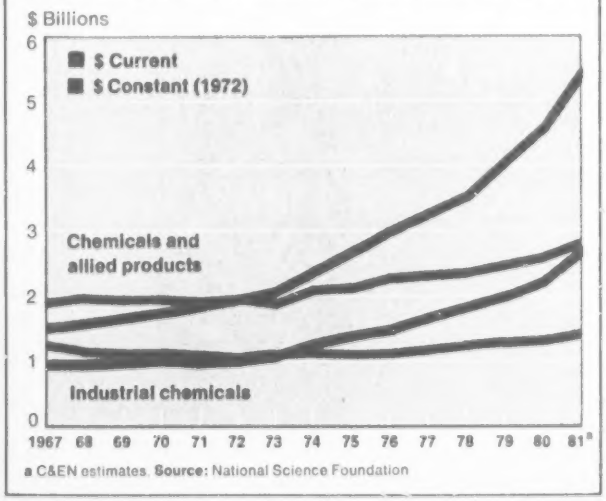
a Planned. b Excludes Conoco. c R&D definition narrowed after 1972. **Sources:** Company data, C&EN estimates

R&D BY U.S. COMPANIES ABROAD: Chemical firms step up spending overseas

$ Millions	1981[a]	1980	1979	1978	1977	1976	1975	1974	Annual change 1980–81	Annual change 1974–81
Chemicals and allied products	$ 700	$ 613	$ 505	$ 399	$ 332	$ 312	$ 269	$ 208	14%	13%
Industrial and other chemicals	280	249	201	153	133	108	85	82	12	13
Drugs	420	364	304	246	199	204	184	126	15	13
Other industries	2800	2583	2277	1810	1545	1347	1185	1092	8	10
TOTAL	$3500	$3196	$2782	$2209	$1877	$1659	$1454	$1300	10%	10%

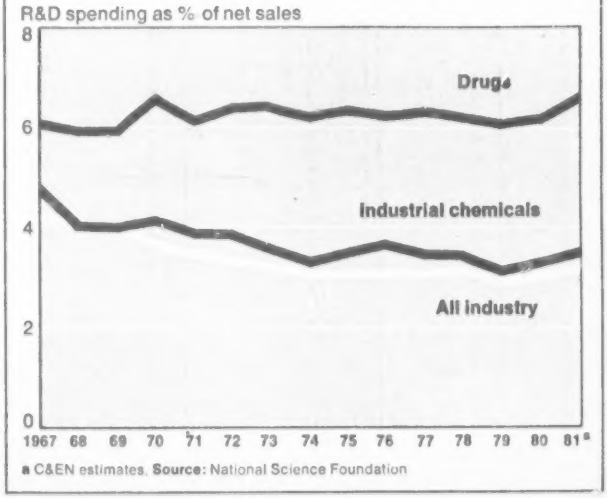
a C&EN estimates. **Source:** National Science Foundation

R&D spending in chemical industry has been outpacing inflation since mid-1970s



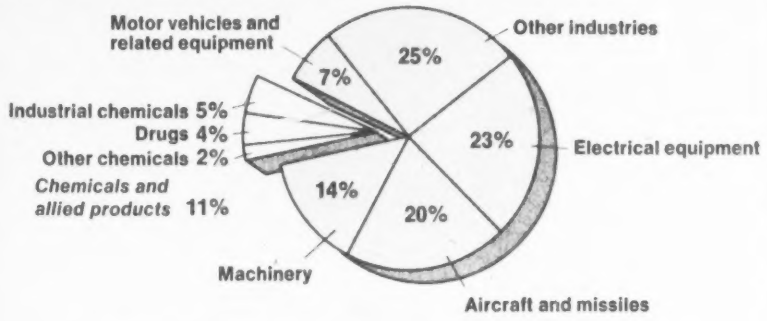
a C&EN estimates. **Source:** National Science Foundation

Outlays for R&D have been rising faster than company sales in past two years



a C&EN estimates. **Source:** National Science Foundation

Chemical industry, overall, employs 11% of all scientists and engineers in industrial R&D



1981 total industrial R&D scientists and engineers[a] = 470,200

a Full-time equivalent. **Source:** National Science Foundation

R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: Chemical producers rank high

	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969
Chemicals and allied products	**41**	**40**	**42**	**42**	**40**	**41**	**40**	**39**	**39**	**41**	**39**	**35**
Industrial chemicals	36	36	38	38	36	38	37	36	34	35	35	32
Drugs	61	61	64	62	64	59	57	57	60	65	65	48
Other chemicals	29	27	26	28	28	29	30	29	31	31	30	31
All industry	**29**	**29**	**28**	**27**	**27**	**26**	**25**	**24**	**24**	**26**	**26**	**26**

Source: National Science Foundation

COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: Tops $100,000 for chemical firms

$ Thousands	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
Chemicals and allied products	**$ 89.6**	**$81.4**	**$73.9**	**$69.1**	**$66.5**	**$60.9**	**$56.3**	**$51.1**	**$47.1**	**$43.7**	**$42.8**
Industrial chemicals	104.7	94.3	85.2	80.0	74.7	67.5	63.5	58.6	54.0	49.2	47.5
Drugs	81.0	72.8	65.8	65.0	63.4	60.9	54.3	51.5	46.5	43.2	40.1
Other chemicals	73.2	68.5	63.0	54.2	50.8	43.2	45.3	34.0	33.4	35.5	33.4
All industry	**95.7**	**87.7**	**80.7**	**76.1**	**72.2**	**66.5**	**63.3**	**59.2**	**55.3**	**51.1**	**48.1**

Source: National Science Foundation

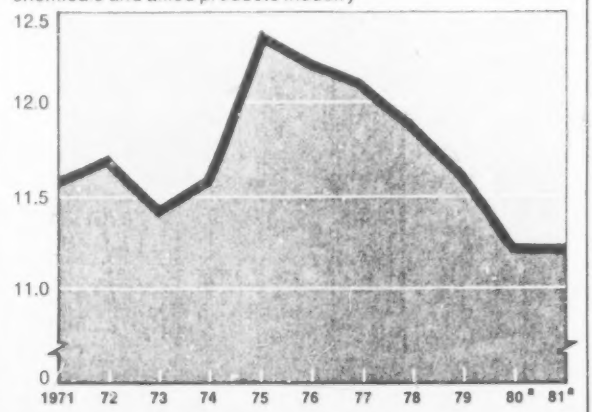
CHEMISTS IN INDUSTRY: More than half work for chemical or drug makers

	% of industrial chemicals			
Industry	All chemists	B.S.	M.S.	Ph.D.
Chemical	35%	31%	30%	40%
Pharmaceutical	17	14	20	17
Petroleum	6	5	4	8
Coatings	5	7	5	3
Food	4	5	5	3
Metals and minerals	3	4	3	2
Rubber	2	4	3	1
Paper	1	1	1	2
Other manufacturing	20	21	22	19
Nonmanufacturing	6	8	7	5

Source: 1982 ACS survey

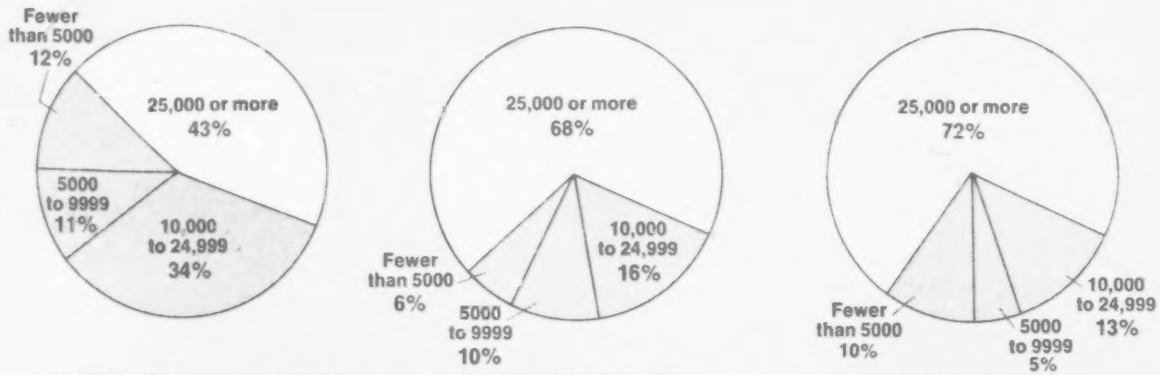
Jobs for scientists in chemical industry have declined relatively since mid-'70s

% of industrial R&D scientists and engineers[a] in the chemicals and allied products industry



a Full-time equivalent. **Source:** National Science Foundation

Most R&D funds are spent by companies with greatest total employment



Total 1980 chemicals and allied products R&D funds = $4.6 billion

Total 1980 industrial chemicals R&D funds = $2.3 billion

Total 1980 industry R&D funds = $43.9 billion

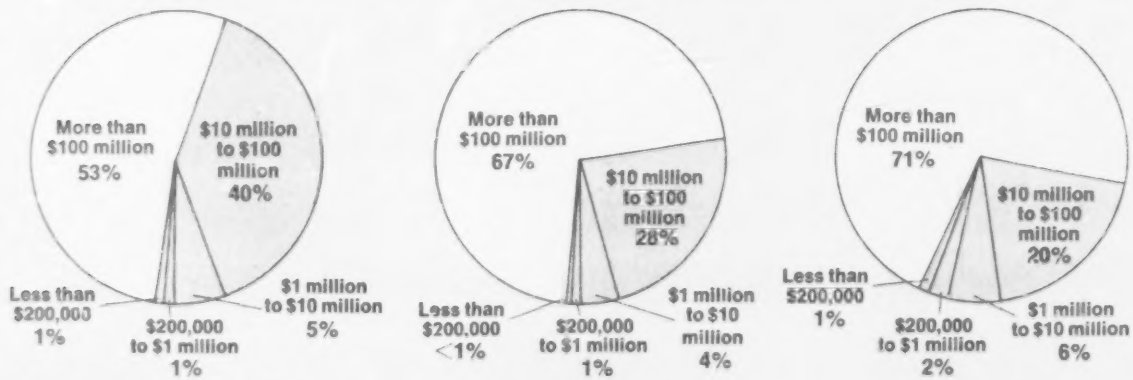
Note: Ranges indicate company's number of employees in 1980. **Source:** National Science Foundation

R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: More than 10% work in chemical industry

Thousands[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971
Chemicals and allied products	52.8	50.0	49.1	47.9	46.4	44.4	45.2	41.8	40.9	41.0	42.7
Industrial chemicals	22.1	21.3	21.6	21.5	20.6	20.1	21.1	19.1	19.1	19.1	21.8
Drugs	21.1	20.0	19.7	18.9	17.8	16.6	15.6	14.0	13.0	13.1	12.3
Other chemicals	9.6	9.7	7.8	7.4	8.0	7.8	8.5	8.7	8.8	8.8	8.6
Other industries	417.4	396.6	374.1	355.8	336.4	320.0	318.1	318.2	316.8	309.2	324.3
TOTAL	470.2	446.6	423.2	403.7	382.8	364.4	363.3	360.0	357.7	350.2	367.0

a Full-time equivalent. **Source:** National Science Foundation

Firms with R&D budgets under $10 million account for less than 10% of total R&D spending


More than $100 million 53%
$10 million to $100 million 40%
Less than $200,000 1%
$200,000 to $1 million 1%
$1 million to $10 million 5%
More than $100 million 67%
$10 million to $100 million 28%
Less than $200,000 <1%
$200,000 to $1 million 1%
$1 million to $10 million 4%
More than $100 million 71%
$10 million to $100 million 20%
Less than $200,000 1%
$200,000 to $1 million 2%
$1 million to $10 million 6%

Total 1980 chemicals and allied products R&D funds = $4.6 billion

Total 1980 industrial chemicals R&D funds = $2.3 billion

Total 1980 industry R&D funds = $43.9 billion

Note: Ranges indicate size of company's 1980 R&D program. **Source:** National Science Foundation

Academic R&D shows moderate growth

Basic research accounts for most academic R&D, but its share of the total spending has dropped from 77% to 66% since 1971

CHARACTER OF UNIVERSITY R&D SPENDING: Basic research's share down to 66%

$ Millions	1981[a]	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	1971	Annual change 1980-81	Annual change 1971-81
Basic research	$4385	$4019	$3607	$3172	$2802	$2548	$2410	$2154	$2053	$2022	$1914	9%	9%
Applied research	1840	1687	1463	1213	1068	1015	851	736	713	524	474	9	15
Development	375	343	284	236	200	164	148	133	118	84	112	9	13
TOTAL	$6600	$6049	$5354	$4621	$4070	$3727	$3409	$3023	$2884	$2630	$2500	9%	10%

a Estimates. b Estimated, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

SOURCE OF UNIVERSITY R&D FUNDS: Institutions' own share is growing most rapidly

$ Millions	1981[a]	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	1971	Annual change 1980-81	Annual change 1971-81
Federal government	$4400	$4093	$3594	$3057	$2730	$2512	$2288	$2032	$1985	$1795	$1724	8%	10%
State and local governments	550	492	469	414	373	363	332	307	295	270	255	12	8
Industry	260	236	193	170	139	123	113	96	84	74	70	10	13
Institutional funds	940	821	725	622	514	445	417	370	318	305	274	14	13
Other sources	450	408	373	359	315	285	259	218	202	187	177	10	10
TOTAL	$6600	$6049	$5354	$4621	$4070	$3727	$3409	$3023	$2884	$2630	$2500	9%	10%

a Estimates. b Estimated, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

FIELDS OF UNIVERSITY R&D SPENDING: Chemistry's share is 4% of the total

$ Millions	1981[a]	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	1970	Annual change 1980-81	Annual change 1970-81
Physical sciences	$ 740	$ 679.7	$ 603.3	$ 496.4	$ 428.4	$ 379.4	$ 350.3	$ 333.5	$ 328.3	$ 324.2	$ 307.3	9%	8%
Chemistry	270	245.6	207.7	183.2	164.3	140.1	120.7	115.8	113.7	108.1	102.0	10	9
Physics	355	329.2	300.8	235.1	201.7	183.1	173.5	169.2	167.0	159.1	161.9	8	8
Engineering	970	862.6	767.8	601.1	498.5	431.7	380.9	346.9	333.1	341.4	318.8	12	11
Total R&D spending	6600	6049.3	5354.4	4621.3	4069.8	3727.2	3408.6	3022.6	2884.0	2630.4	2334.9	9	10

a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal years; 1971 not available. **Source:** National Science Foundation

FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Growth last year below average

$ Millions	1981[a]	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	1970	Annual change 1980-81	Annual change 1970-81
Physical sciences	$ 600	$ 555.3	$ 491.1	$ 392.3	$ 342.8	$ 305.4	$ 285.0	$ 270.2	$ 268.4	$ 261.0	$ 257.8	8%	8%
Chemistry	205	189.3	157.0	138.0	125.4	107.9	92.7	88.7	86.6	82.6	78.9	8	9
Physics	305	286.9	261.4	199.2	171.9	156.1	149.9	146.5	145.4	136.3	144.3	6	8
Engineering	660	594.5	526.4	407.5	336.7	290.5	259.4	239.3	238.1	252.5	245.9	11	9
Total R&D spending	4400	4092.6	3594.4	3057.2	2729.8	2511.6	2288.1	2032.2	1985.4	1795.0	1647.5	8	9

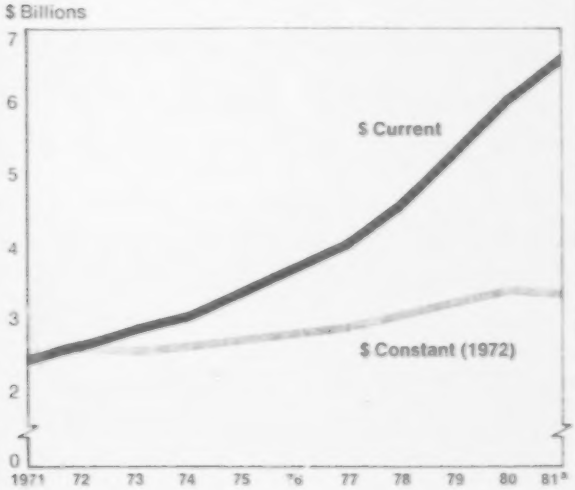
a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal years; 1971 not available. **Source:** National Science Foundation

TOP 12 UNIVERSITIES IN R&D SPENDING: Johns Hopkins has largest science outlays

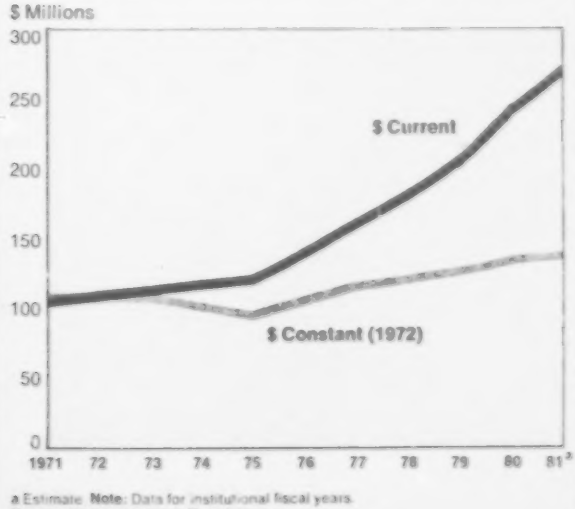
$ Millions, fiscal 1980	Physical sciences	Chemistry[a]	Engineering	Environmental sciences	Life sciences	Math and computer sciences	Other sciences[b]	Total
Johns Hopkins University	$48.2	$4.7	$55.9	$28.4	$70.1	$42.0	$ 8.6	$253.2
Massachusetts Institute of Technology	46.4	6.8	69.6	8.9	20.7	9.0	9.1	163.6
University of Wisconsin, Madison	15.8	6.6	11.3	13.1	70.7	4.6	22.7	138.2
University of California, San Diego	20.1	4.5	2.0	60.0	39.7	0.7	2.3	124.8
University of Minnesota	6.6	2.6	9.3	2.2	90.7	1.4	9.0	119.1
Stanford University	17.3	4.8	33.3	2.3	46.8	7.1	6.2	113.1
University of Washington	5.4	1.3	5.4	16.4	70.6	0.9	13.1	111.9
University of Michigan	6.5	2.1	15.2	12.1	50.7	1.7	25.1	111.3
Cornell University	17.2	3.8	14.5	3.4	62.4	1.5	8.8	107.6
Columbia University, main division	10.4	4.4	7.7	17.9	58.2	0.6	6.6	101.4
Harvard University	13.4[c]	4.6[c]	2.8[c]	5.5[c]	66.6[c]	1.8[c]	10.7[c]	100.9[c]
University of Pennsylvania	9.1	3.7	4.4	0.7	58.8	3.5	17.7	94.2

a Included in physical sciences. b Includes social sciences, psychology, and other sciences not listed separately. c Estimate. **Source:** National Science Foundation

Total outlay for academic R&D, in real terms, generally is up from early 1970s...



...and spending for academic R&D in chemistry has fared even better since 1975



a Estimate. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

TOP 12 UNIVERSITY R&D CENTERS:[a] Most funding goes for physical science

$ Millions, fiscal 1980	Physical sciences	Engineering	Environmental sciences	Life sciences	Total[b]
Lawrence Livermore National Lab	$286.0	$ 52.1	$35.9	$ 3.3	$401.1
Jet Propulsion Lab	65.5	201.6	16.6	4.2	385.5
Los Alamos National Lab	178.1	120.0	8.2	13.9	375.4
Argonne National Lab	84.6	134.8	50.3	14.2	286.7
Brookhaven National Lab	80.8	21.9	9.2	17.5	137.7
Lincoln Lab	26.6	95.2	0	0	135.0
Lawrence Berkeley Lab	70.3	12.8	25.0	18.6	130.6
Plasma Physics Lab	126.0[c]	0	0	0	126.0[c]
Fermi National Accelerator Lab	83.2	0	0	0	83.2
Stanford Linear Accelerator Center	66.5	0	0	0	66.5
National Center for Atmospheric Research	5.9	0	28.0	0	33.9
Ames Laboratory	11.3	5.2	0.1	0	16.7

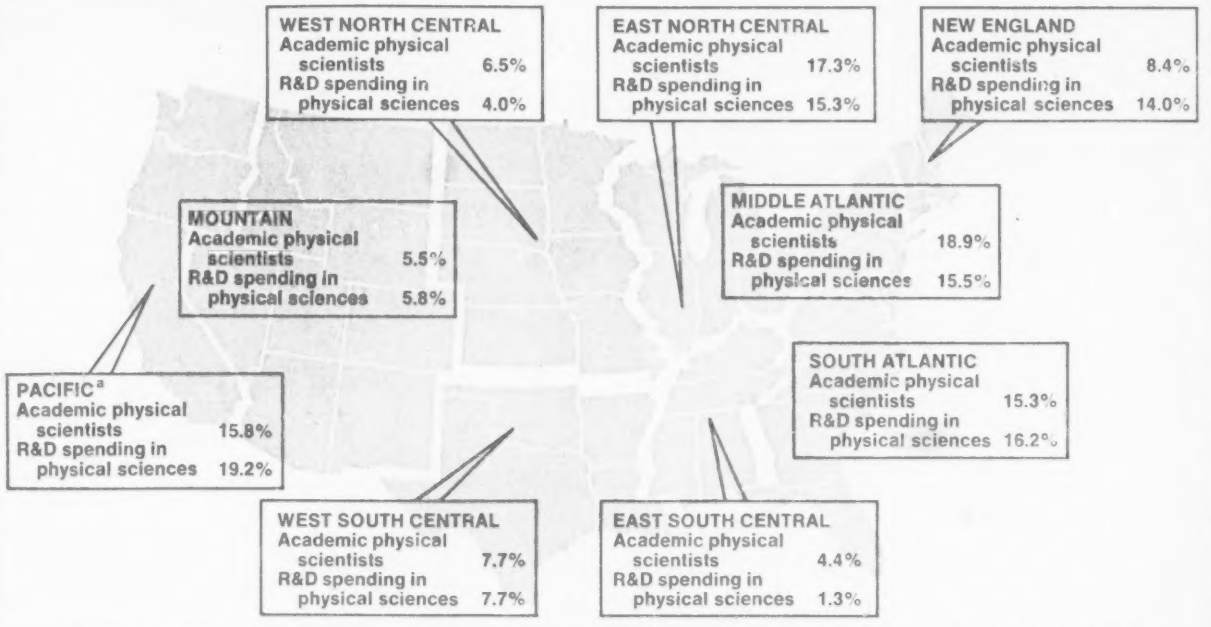
a Data for university-administered federally funded R&D centers. b Includes sciences not listed separately. c Estimate. **Source:** National Science Foundation

ACADEMIC SCIENTISTS AND ENGINEERS: Employment of chemists up 3% last year

Thousands of scientists and engineers[a]	1981	1980	1978	1977	1976	1975	1974
TOTAL							
Physical scientists	**34.1**	**33.6**	**32.8**	**32.1**	**31.4**	**30.8**	**30.6**
Chemists	18.1	17.6	17.7	17.1	16.6	16.2	16.1
Physicists	12.9	13.0	12.8	12.5	12.2	12.3	12.1
Engineers	**34.8**	**33.7**	**31.0**	**30.1**	**28.5**	**27.9**	**27.2**
Chemical	2.3	2.4	2.0	1.9	1.9	1.9	1.7
Other scientists	**264.6**	**256.8**	**243.8**	**235.5**	**228.3**	**220.2**	**210.7**
TOTAL	**333.4**	**324.1**	**307.6**	**297.8**	**288.2**	**278.9**	**268.5**
FULL-TIME ONLY							
Physical scientists	**28.2**	**28.0**	**27.9**	**27.6**	**27.1**	**26.7**	**26.8**
Chemists	14.8	14.3	14.7	14.5	14.1	13.8	14.1
Physicists	11.0	11.3	11.2	11.1	10.8	10.9	10.9
Engineers	**27.0**	**26.5**	**24.7**	**24.1**	**22.9**	**22.6**	**22.8**
Chemical	1.9	1.9	1.7	1.7	1.6	1.6	1.5
Other scientists	**203.7**	**200.4**	**189.5**	**184.5**	**179.8**	**174.1**	**168.8**
TOTAL	**258.8**	**254.9**	**242.1**	**236.2**	**229.8**	**223.3**	**218.4**

a In January. **Note:** Data not available for 1979. **Source:** National Science Foundation

Nearly two thirds of academic physical scientists and academic R&D in physical science are east of the Mississippi


WEST NORTH CENTRAL
Academic physical scientists 6.5%
R&D spending in physical sciences 4.0%
EAST NORTH CENTRAL
Academic physical scientists 17.3%
R&D spending in physical sciences 15.3%
NEW ENGLAND
Academic physical scientists 8.4%
R&D spending in physical sciences 14.0%
MOUNTAIN
Academic physical scientists 5.5%
R&D spending in physical sciences 5.8%
MIDDLE ATLANTIC
Academic physical scientists 18.9%
R&D spending in physical sciences 15.5%
SOUTH ATLANTIC
Academic physical scientists 15.3%
R&D spending in physical sciences 16.2%
PACIFIC[a]
Academic physical scientists 15.8%
R&D spending in physical sciences 19.2%
WEST SOUTH CENTRAL
Academic physical scientists 7.7%
R&D spending in physical sciences 7.7%
EAST SOUTH CENTRAL
Academic physical scientists 4.4%
R&D spending in physical sciences 1.3%

Key to map: Using the Middle Atlantic states as an example, 18.9% of all physical scientists employed at universities and colleges are located in this geographical area and 15.5% of all R&D expenditures in the physical sciences by universities and colleges are in this area. a Includes Alaska and Hawaii. **Note:** Data are based on 33,694 physical scientists employed at universities and colleges in the U.S. as of January 1981, and R&D expenditures of $679.2 million in the physical sciences during these institutions' 1980 fiscal year; data exclude universities and colleges in outlying areas. **Source:** National Science Foundation

CHEMICAL DEGREES: Engineering degrees increase, but those in chemistry decline a bit

Academic year	Degrees awarded in chemistry[a]			Degrees awarded in chemical engineering		
	Bachelors	Masters	Ph.D.s	Bachelors	Masters	Ph.D.s
1965–66	9,735	1839	1571	2848	994	354
1966–67	9,872	1831	1744	2869	949	305
1967–68	10,847	2014	1757	3211	1156	367
1968–69	11,807	2070	1941	3557	1136	409
1969–70	11,617	2146	2208	3720	1045	438
1970–71	11,183	2284	2160	3615	1100	406
1971–72	10,721	2259	1971	3663	1154	394
1972–73	10,226	2230	1882	3636	1051	397
1973–74	10,525	2138	1828	3454	1045	400
1974–75	10,649	2006	1824	3142	990	346
1975–76	11,107	1796	1623	3203	1031	308
1976–77	11,322	1775	1571	3581	1086	291
1977–78	11,474	1892	1525	4615	1237	259
1978–79	11,643	1765	1518	5655	1149	304
1979–80	11,446	1733	1551	6383	1271	284

a Does not include biochemistry and geochemistry. **Source:** Department of Education's National Center for Education Statistics

GRADUATE SCIENCE STUDENTS: Engineering outgains physical sciences

Thousands	1980	1979	1978	1977	1976	1975	1974
TOTAL							
Physical sciences	25.4	24.9	24.7	24.9	24.8	24.6	24.5
Chemistry	15.1	14.9	14.8	14.6	14.4	14.1	13.7
Physics	9.6	9.3	9.2	9.5	9.7	9.7	10.0
Engineering	72.3	68.9	65.8	65.8	64.2	64.6	56.6
Chemical	6.1	5.6	5.3	5.2	5.2	5.1	4.7
Metallurgical and materials	2.8	2.6	2.5	2.5	2.3	2.3	2.2
Petroleum	0.5	0.4	0.4	0.4	0.4	0.3	0.3
Biological sciences	42.1	42.1	42.7	42.7	41.6	40.6	37.6
Biochemistry	3.8	3.8	3.9	3.8	3.7	3.7	3.7
Other sciences[a]	193.3	184.7	176.6	173.1	167.5	163.9	146.6
TOTAL	333.1	320.5	309.8	306.5	298.1	293.6	265.3
FULL-TIME ONLY							
Physical sciences	22.3	21.8	21.5	21.8	21.6	21.3	21.3
Chemistry	13.1	12.8	12.7	12.6	12.4	12.0	11.8
Physics	8.5	8.3	8.2	8.5	8.5	8.5	8.8
Engineering	42.5	39.8	37.4	37.1	36.5	37.1	33.6
Chemical	4.6	4.3	4.0	4.0	3.8	3.6	3.3
Metallurgical and materials	2.2	2.1	1.9	1.9	1.8	1.8	1.6
Petroleum	0.4	0.3	0.3	0.3	0.3	0.2	0.2
Biological sciences	35.3	35.3	35.5	35.8	35.2	34.5	32.2
Biochemistry	3.6	3.5	3.6	3.5	3.4	3.4	3.5
Other sciences[a]	130.6	126.5	122.1	122.8	120.7	117.3	108.4
TOTAL	230.6	223.4	216.6	217.4	214.1	210.3	195.5

a Includes environmental, mathematical, health, agricultural, social sciences, psychology **Note:** Data for Ph.D.-granting institutions only. **Source:** National Science Foundation

SCHOOLS SPENDING MOST ON CHEMICAL R&D: Top 50 account for nearly two thirds of total

$ Thousands	Total spending				Federally financed spending			
	1980	1979	1978	1977	1980	1979	1978	1977
1 Massachusetts Inst. of Technology	$ 6,764	$ 5,324	$ 6,242	$ 4,735	$ 6,311	$ 5,021	$ 5,837	$ 4,351
2 U of Wisconsin, Madison	6,643	5,450	5,149	5,136	3,779	2,865	2,933	2,880
3 California Inst. of Technology	6,328	5,297	4,108	5,143	5,630	4,813	3,712	4,322
4 U of California, Berkeley	6,022	3,717	3,046	3,090	5,601	3,485	2,758	2,742
5 Harvard U	4,797[a]	4,283[a]	3,905[a]	2,958	3,631	3,241	3,396	2,566
6 Stanford U	4,788	4,159	3,549[a]	2,659	4,609	3,775	3,266	2,581
7 Johns Hopkins U	4,652	4,064[a]	1,160	1,160	4,444	3,968[a]	1,034	1,102
8 U of California, San Diego	4,471	4,225	3,611	3,344	4,087	3,913	3,293	3,064
9 Columbia U, main division	4,437	3,531	3,321	2,975	4,054	3,202	2,854	2,747
10 U of Illinois, Urbana	4,261	3,963	3,211	2,438	3,424	2,696	2,426	2,045
Total, first 10 institutions	53,163	44,013	37,302	33,638	45,570	36,979	31,559	28,400
11 U of California, Los Angeles	4,159	3,573	3,236	2,563	4,017	3,379	3,052	2,408
12 Texas A&M U	4,097	3,715	3,261	3,894	2,945	2,361	2,243	2,205
13 U of Texas, Austin	3,970	3,373	3,057	2,361	2,564	2,282	1,931	1,286
14 U of Chicago	3,958[a]	3,418[a]	3,113[a]	2,789	3,558	3,039	2,803	2,684
15 Cornell U	3,808	3,414	3,423	3,048	3,404	3,087	3,137	2,888
16 U of Pennsylvania	3,688	2,211	1,761	973	3,143	1,840	1,356	762
17 Georgia Inst. of Technology	3,655	3,577	2,784	2,013	2,118	2,110	1,551	1,075
18 Purdue U	3,596	3,438	2,857	2,545	3,151	3,087	2,500	2,170
19 U of Notre Dame	3,457	2,746	2,475	2,560	3,328	2,618	2,389	2,461
20 U of Colorado	3,332	2,544	899	992	2,605	1,942	688	902
Total, first 20 institutions	90,883	76,022	64,168	57,376	76,403	62,724	53,209	47,241
21 Indiana U	3,147	2,644	2,234	1,616	2,635	2,306	1,959	1,484
22 Pennsylvania State U	2,973	2,303	1,904	1,452	2,527	1,989	1,590	1,309
23 U of Utah	2,811	2,290	2,754	7,149	2,373	1,949	1,909	5,636
24 Florida State U	2,791	2,478	1,490[b]	1,470	1,313	1,160	777[b]	727[a]
25 U of Maryland, College Park	2,766	1,907	1,975	1,389	2,292	1,628	1,690	959
26 Ohio State U	2,654	2,039	1,740	2,015	2,144	1,743	1,493	1,738
27 U of Minnesota	2,642	2,162	1,803	1,667	2,143	1,624	1,415	1,279
28 Northwestern U	2,367	1,851	1,854	1,250	2,221	1,671	1,681	1,068
29 U of Southern California	2,313	2,181	1,676	764	1,773	1,731	1,381	722
30 U of Nebraska, Lincoln	2,289	1,745	1,040	391	1,909	983	769	347
Total, first 30 institutions	117,636	97,622	82,638	76,539	97,733	79,508	67,373	62,510
31 U of Florida	2,283[a]	1,968	1,265	769	1,214[a]	1,339	1,077	686
32 Wayne State U	2,163	2,022	2,740	1,280	1,640	1,555	1,926	1,172
33 U of Rochester	2,089	2,536	2,100	1,987	1,667	2,056	1,695	1,519
34 Carnegie-Mellon U	2,075	1,957	3,828	4,425	1,515	1,403	1,542	1,079
35 Princeton U	2,065	2,242	1,660	1,508	1,646	1,621	1,271	1,113
36 U of Michigan	2,064	1,406	1,171	851	1,775	1,229	982	604
37 Yale U	2,023	2,107	1,444	1,532	1,886	1,750	1,379	1,455
38 Colorado State U	1,973	1,774	1,398	1,100	1,717	1,579	1,193	853
39 State U of New York, Stony Brook	1,966	1,801	1,637	1,201	1,632	1,554	1,281	1,050
40 Case Western Reserve U	1,938	1,413	1,190	1,119	1,617	1,145	940	973
Total, first 40 institutions	138,275	116,848	101,071	92,391	114,042	94,739	81,159	73,[illegible]
41 U of Massachusetts, Amherst	1,889	2,621	2,038	1,922	1,632	1,921	1,633	1,308
42 U of North Carolina, Chapel Hill	1,789	1,685	1,413	1,471	1,752	1,666	1,398	1,448
43 U of Arkansas, Fayetteville	1,674[a]	1,180[a]	1,765	249	370	281	295	217
44 State U of New York, Buffalo	1,665	1,143	1,008	966	1,163	817	735	894
45 U of Pittsburgh	1,641	1,728	1,709	1,542	1,[illegible]	1,416	1,201	1,328
46 Michigan State U	1,638	1,491	1,262	1,266	1,157	1,045	878	1,063
47 Virginia Polytechnic Inst. & State U	1,612	1,281	1,134[a]	987	1,047	875	714[a]	674
48 U of California, San Francisco	1,564	1,235	1,110	850	1,536[a]	1,201	976	792
49 Louisiana State U	1,561	1,161	1,204	927	873	620	635	661
50 Rensselaer Polytechnic Inst.	1,551	968	900	811	962	680[a]	660	605
TOTAL, FIRST 50 INSTITUTIONS	$154,859	$131,341	$114,614	$103,382	$125,900	$105,261	$ 90,334	$ 82,004
NATIONAL TOTAL	$245,610	$207,674	$183,131	$164,302	$189,349	$156,950	$138,001	$125,440

a Estimate. b Imputed. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation